PROCEEDINGS

OF THE

Royal Canadian Institute

SERIES IIIA SESSION 1941-1942 VOLUME VII

This publication is issued with the object of conveying a general idea of what the Royal Canadian Institute endeavours to do, along with a brief outline of what it has done in the past. The publication contains abstracts of the popular scientific lectures given each Saturday Evening in Convocation Hall, University of Toronto during the 93rd Session 1941-1942.

198 COLLEGE STREET
TORONTO, CANADA

CONTENTS

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of

The Royal Canadian Institute

1942-1943

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Address: 198 College Street, Toronto, Canada

PRESIDENTS OF THE ROYAL CANADIAN INSTITUTE SINCE ITS FOUNDATION IN 1849

HON. H. H. KILLALY	1849-50
CHARLES RANKIN, C.E.	1850
(Royal Charter granted November 4th, 1851)	
WILLIAM (AFTERWARDS SIR WILLIAM) E. LOGAN, C.E., F.R.S., ETC.	1850-51, 1851-52
CAPTAIN (AFTERWARDS GENERAL SIR J. HENRY) LEFROY, R.A., F.R.S., ETC.	1852-53
HON. CHIEF JUSTICE (AFTERWARDS SIR J. BEVERLEY) ROBINSON	1853-54, 1854-55
G. W. (AFTERWARDS HON. G. W.) ALLAN	1855-56
HON. CHIEF JUSTICE DRAPER, C.B.	1856-57, 1857-58
HON. G. W. ALLAN	1858-59
PROF. (AFTERWARDS SIR) DANIEL WILSON, LL.D., F.R.S.E.	1859-60, 1860-61
HON. (AFTERWARDS CHIEF JUSTICE) J. H. HAGARTY	1861-62
REV. J. McCAUL, LL.D.	1862-63, 1863-64
HON. (AFTERWARDS SIR) OLIVER MOWAT	1864-65, 1865-66
PROF. HENRY CROFT, D.C.L.	1866-67, 1867-68
REV. PROF. WILLIAM HINCKS, F.L.S.	1868-69, 1869-70
REV. HENRY SCADDING, D.D.	1870-71, 1871-72, 1872-73, 1873-74, 1874-75, 1875-76
PROF. JAMES LOUDON, M.A., F.R.S.C.	1876-77, 1877-78
PROF. (AFTERWARDS SIR) DANIEL WILSON, LL.D., F.R.S.E.	1878-79, 1879-80, 1880-81
JOHN LANGTON, M.A.	1881-82
J. M. BUCHAN, M.A.	1882-83, 1883-84
PROF. W. H. ELLIS, M.A., M.B.	1884-85, 1885-86
W. H. VANDER SMISSEN, M.A.	1886-87, 1887-88
CHARLES CARPMAEL, M.A., F.R.S.C.	1888-89, 1889-90, 1890-91
ARTHUR HARVEY, F.R.S.C.	1891-92, 1892-93
R. RAMSAY WRIGHT, M.A., LL.D., F.R.S.C.	1893-94, 1894-95
A. B. MACALLUM, M.A., PH.D., LL.D., F.R.S.	1895-96, 1896-97, 1897-98
B. E. WALKER, D.C.L., F.G.S. (AFTERWARDS SIR EDMUND)	1898-99, 1899-1900
JAMES BAIN, D.C.L.	1900-01, 1901-02
A. P. COLEMAN, PH.D., F.R.S.	1902-03, 1903-04
GEORGE KENNEDY, M.A., LL.D., K.C.	1904-05, 1905-06
R. F. STUPART (AFTERWARDS SIR FREDERIC)	1906-07, 1907-08
J. J. MACKENZIE, B.A., M.D.	1908-09, 1909-10
J. B. TYRRELL, M.A., F.R.S.C.	1910-11, 1911-12, 1912-13
F. ARNOLDI, K.C.	1913-14, 1914-15, 1915-16
J. C. McLENNAN (AFTERWARDS SIR JOHN), PH.D., F.R.S.	1916-17
J. MURRAY CLARK, LL.B., K.C.	1917-18, 1918-19
PROF. J. C. FIELDS, PH.D., F.R.S.	1919-20, 1920-21, 1921-22, 1922-23, 1923-4, 1924-25
PROF. J. J. R. MACLEOD, D.Sc., LL.D., F.R.S.	1925-26
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PROF. W. A. PARKS, PH.D., F.R.S.	1928-29
PROF. R. B. THOMSON, B.A., F.R.S.C.	1929-30
T. A. RUSSELL, B.A., LL.D.	1930-31
E. F. BURTON, B.A., TOR., CAMB., PH.D., F.R.S.C.	1931-32
JOHN PATTERSON, M.A., F.R.S.C.	1932-33
SIR ROBERT A. FALCONER, K.C.M.G., D.LITT., LL.D., D.C.L., OX., F.R.S.C.	1933-34, 1934-35
J. ELLIS THOMSON, B.A.Sc., PH.D., F.R.S.C.	1935-36, 1936-37, 1937-38
ARTHUR R. CLUTE, K.C.	1938-39
PROF. J. R. DYMOND, M.A., F.R.S.C.	1939-40
WILLS MACLACHLAN, B.A.Sc.	1940-41
PROF. L. JOSLYN ROGERS, B.A.Sc., M.A.	1941-42
PROF. T. F. McILWRAITH, M.A., (Cantab.), F.R.S.C.	1942-

Historical Note.

ON June 20th, 1849, a small gathering of surveyors, architects, and civil engineers, practising in and around Toronto, met in the office of Mr. Kivas Tully, to form an association of members of the three professions throughout the province. Out of this grew the Canadian Institute.

The original members of the Institute were William E. (later Sir William) Logan, John O. Brown, Frederick F. Passmore, Kivas Tully, William Thomas Ridout, and Sandford (later Sir Sandford) Fleming. Of these, Sir Sandford Fleming, the originator and founder of the Institute, was the last survivor. He died on July 22nd, 1915, 66 years after its foundation. The association was incorporated by Royal Charter granted on the 4th of November, 1851, and became known as the "Canadian Institute."

Sir William Logan, who was the first president of the Canadian Institute, was succeeded in 1852 by Captain (afterwards General Sir J. Henry) Lefroy, R.A., F.R.S., Director of the Imperial Magnetic Service in Toronto and later Governor of Tasmania and of Bermuda.

Beginning with the year 1851, there was published by the Institute "The Canadian Journal: A repertory of Industry, Science and Art," under the editorship of Henry Youle Hind, who had conducted explorations in Western Canada, and was then Professor of Chemistry in Trinity University. In a later series the Rev. Henry Scadding, D.D., who was president of the Institute from 1870 to 1876, published his well-known series of "Collections and Recollections on Toronto."

Weekly meetings of the Institute have been held consecutively each year from November to April since the Royal Charter was granted in 1851. At the earlier meetings, papers on scientific problems of the day were read and discussed, and practical work was carried on by the various sections which were under the administration of the Institute. The most outstanding of these were the Biological Section, the Geological and Mining Section, and the Historical Section.

About the beginning of this century it was felt that the discussion of scientific papers did not convey to the public the benefit of the knowledge involved in them, nor the important results that had been attained. In order, therefore, to establish a more direct communication with the public, the system of weekly Saturday evening lectures was begun, with the object of directing the attention of the people to questions of public interest and utility on which scientific opinion might have an important bearing.

A few of the accomplishments of the Institute are to be found on the following pages, and from them it may be seen that the objects of the charter, granted in 1849, have been pursued steadily ever since.

On the 2nd of April, 1914, His Majesty the King granted permission to change the name to "Royal Canadian Institute."

Some of the Outstanding Accomplishments of the Royal Canadian Institute

1. Co-operation in promoting the meetings in Toronto of the following scientific societies:

(a) The American Association for the Advancement of Science, 1889 and 1921.

(b) The British Association for the Advancement of Science, 1897 and 1924.

(c) The International Geological Congress, 1913.

(d) The International Mathematical Congress, 1924.

2. Standard Time.

In 1878 Sir Sandford Fleming brought forward the plan of adopting for the whole earth, twenty-four standard meridians, fifteen degrees apart in longitude. He published many papers on this subject, and with the co-operation of the Institute, the zone system of time-reckoning was adopted in most of the countries of the world.

3. The Museum.

The Ontario Archaeological Museum was begun under the auspices of the Institute, and continued under its management for six years before being transferred to the Ontario Government and the University of Toronto.

4. Publications.

The Publications of the Institute have appeared in four principal series and one minor series as follows:—

(1) "The Canadian Journal: a Repertory of Industry, Science and Art," and a Record of the Proceedings of the Canadian Institute. 3 vols., 4to. Begun August, 1852, ended December, 1855.

(2) "The Canadian Journal of Science, Literature and History." 15 vols., 8vo. Begun January, 1856, ended January, 1878.

(3) "Proceedings of the Canadian Institute" 7 vols. Begun 1879, ended April, 1890.

(4) The Archaeological Reports of the Canadian Institute were published as part of the Appendix to the Report of the Minister of Education for the Province of Ontario, 1886-1904.

(5) Minor Series. "Proceedings of the Canadian Institute." From 1897 to 1904, two volumes of this series, containing short papers, were published.

(6) "Transactions of the Royal Canadian Institute." Begun October, 1890, and up to October, 1941, Part 2 of the twenty-third volume has been published. This publication contains scientific papers on technical subjects, relating to all branches of science. These papers are submitted by those doing research work. The publication is sent to learned societies throughout the world, and these societies send their own publications in exchange. Any Ordinary member of the Royal Canadian Institute may receive a copy of this publication upon request.

(7) "Proceedings of the Royal Canadian Institute." Series IIIA. Abstracts of the lectures given during the year. Begun 1936 and to date six volumes have been published.

(8) General Index to Publications, 1852-1912. Compiled and edited by Mr. John Patterson. Dr. J. B. Tyrrell, President of the Institute, 1910-1913, undertook to finance the compilation of the index, and made it possible for the Council to proceed with the work.

5. The Library.

As a result of the exchange of publications with learned societies for the past ninety-two years, the Institute has built up a most important scientific library of over thirty thousand volumes, many of which are indispensable to scientific workers in this part of Canada. For protection against fire, this library is housed in a section of the library of the University of Toronto, and may be used by the staff and students of the University as well as by members of the Institute.

6. The National Research Council and the Ontario Research Foundation.

It was in large part due to the vigorous campaign of the Institute on behalf of a wider application of science to industry in Canada, that the Honorary Advisory Council for Scientific and Industrial Research, the forerunner of the National Research Council, was appointed by the Dominion Government, and that the Ontario Research Foundation was instituted through the co-operation of the Ontario Provincial Government and manufacturers.

7. University Grant.

The Institute also strongly supported the successful application to the Provincial Legislature for an annual grant for research in the University of Toronto.

Report of the President

1941-1942

As presented to the 93rd Annual Meeting, Saturday, April 18th, 1942, held in the Royal Ontario Museum.

A year ago we looked forward to the future with many questions on our minds. —How would the course of events affect the activities of the Royal Canadian Institute?—What part might the Institute play in the furtherance of this country's war effort?—What could we do to help win the war?—We knew that an influential organization such as the Royal Canadian Institute could do more as a body than could any individual. We were aware that there were, and still are, a number of organizations carrying on splendid work in attempting to bring this war to a victorious conclusion. Important as it is to do this, we must realize that we must win the peace as well as the war, and we cannot win the peace by defeating our enemies in battle. I am perfectly convinced that we are entering upon a new kind of life and it is up to organizations like the Royal Canadian Institute to give the proper leadership in establishing sound principles in a new way of living. We, as individuals, cannot afford to be selfish, either in knowledge or private possessions. We must think of others and work together in a combined effort.

We have had two main objectives, therefore, during the past year:—

The first, to attempt to develop favourably the public morale by having a certain number of lectures dealing with the war and Canada's contribution and other lectures aimed to divert our minds from the chaos of the present day into the realm of relaxation.

Secondly we have co-operated with several other organizations in preparing a plan for the re-habilitation of returned men and at the same time making wise use of our natural resources.

Our members have received a report of what came to be known as the Guelph Conference on the Conservation of the Natural Resources of Ontario. The Council has declared itself to be in favour of this plan, and we have every reason to expect that the Dominion Government may find it useful in solving post-war problems.

Through the generous co-operation of our members and the support of a very active and energetic Council we have managed to carry on to the best of our ability the usual activities of the Royal Canadian Institute which may be divided in three departments:

1. Lectures:

Taking a general view of our course of twenty lectures, I believe we have been most successful in having a well balanced programme. Each lecturer has made an excellent contribution to our object which is to develop an appreciation of science and to show what scientific principles might do if applied in the right direction. The lectures covered a wide variety of subjects. Of the twenty speakers, six were from the United States, five from other places outside of Toronto and other parts of Canada, one from England and eight were residents of Toronto.

I wish to take this opportunity to thank all those—members of the Lecture Committee, as well as many private members—who have given valuable advice and assisted so generously in making our programme of lectures so successful.

2. The Library.

Although owing to current conditions the number of publications received from other scientific organizations has been drastically reduced (exchange relations cut from 382 to 338) we have taken advantage of this situation to bring up to date many volumes that we had not been able to have bound previously owing to lack of funds. Through the wise guidance of our Honorary Librarian, Dr. E. H. Craigie, and with the very capable assistance of Mr. D. Bruce Murray and Mrs. C. S. Rawlings, our special scientific Library is gradually becoming more and more useful not only to local research workers but to many scientists in various parts of the Dominion and the United States. I shall not burden you with statistics but if any person would like to know more about the Royal Canadian Institute Library, I should recommend that they study the report of the Honorary Librarian, which report I hope may be included in the next number of our Proceedings. This brings me to our third department—

3. Publications:

Each year we publish what is known as "The Proceedings," a sort of year book of our activities. The Proceedings contain what I personally believe to be an excellent summary of each lecture given during the year. In some cases, and on popular demand, we include the complete lecture, but it is always most difficult to choose one lecture for publication in full, as against another, for they are all worthy of preservation. And, moreover, it takes more money than we can afford.

We also publish what is known as the "Transactions of the Royal Canadian Institute." This publication contains technical scientific papers on various scientific subjects that have been submitted to our Editorial Committee of which Dr. E. M. Walker is the chairman. The Institute owes a great deal to Dr. Walker for his painstaking efforts in editing both our publications. I hope we may continue to profit by his generous assistance for many years.

To operate these three departments successfully we must have the financial support of a strong membership. It has been most gratifying this year to the Council, and to me personally, to see so many of our members willing to give their valuable time and assistance to the work of bringing our activities to the attention of many prominent citizens and of soliciting their financial support.

I wish I could read out to you the names of those who have acted on our membership committee, but there are fifty of them, and it would take much too long. If I mention only the name of the Chairman of this committee, Mr George C. Gale, and extend to him our thanks they will understand that we appreciate what they have done. You may ask what has this committee done. They have made it possible for us to have the best financial year in the history of the Institute even through very trying times. Our membership now stands at a total of 1,476, being an increase over the total of the previous year of 99.

Each year the Institute is saddened by the death of some of its members. This year we have lost twenty-nine members. This loss is greatly felt. We have been fortunate in having their assistance, support and guidance and their influence will live on.

We could not have accomplished all we did this year without a strong campaign committee, and we cannot have a strong committee without having an energetic, enthusiastic and capable chairman. So, in the person of Mr. George C. Gale, as chairman, we were indeed fortunate. I could not say too much about Mr. Gale and the contribution he has made to the work of the Institute. We all know his devotion to this work. His name should be engraved on our records as one to whom the Royal Canadian Institute will be eternally grateful. For the last ten years Mr. Gale has served the Institute faithfully, his only reward being the satisfaction of knowing that his work was worthwhile and that his task was well done. I regret that I have to announce his wish to resign as Honorary Treasurer, and it is only because we owe so much to him already that we are compelled to abide by his wish. We hope that in the not too distant future we may have the privilege of having him act with us again on the Council.

Each year, in accordance with our constitution, we lose the services of some of the members of our Council. This year from the Council, the following also retire: Dr. E. S. Moore and Mr. Arthur R. Clute. These two gentlement have served the Council well. We are not going to lose them, for I am sure they have the welfare of the Institute at heart and it is hoped that their advice may be available in the future.

To me, one of the most inspiring features of my pleasant associations with the Royal Canadian Institute has been the generous way in which so many have done even more than their share. It is good to have friends that one can count on and the Institute is blessed with a great many. A number of ladies and gentlemen have greatly assisted in entertaining our

lecturers while in Toronto. Many of our members have made it possible for our speakers to meet other people who are interested in their work and much is gained from conversation with many of the outstanding scientists who come to the Institute.

The books of the Institute have been audited and the signed certificate of the Auditors that the books and the accounts are in good order has been placed in the hands of the Honorary Treasurer. The Honorary Treasurer will be pleased to show the detailed report to any member wishing to review it. For the year ending March 31st last the receipts totalled approximately $8,800 included in which is the government grant of $500 towards the Library expenditures. On the lectures was expended approximately $1,400, on the Library and publications $2,300, and on administration, building upkeep, office expenses, etc., $4,900. This leaves a small credit balance of approximately $200 on the year's operations. Many opportunities offer for the advancement of science, for works of conservation and for post-war rehabilitation of men returned from overseas. These form the ordinary activities of the Institute and we engage in them so far as is possible, but are handicapped through the lack of funds. An application for an increased governmental grant must be made and additional grants from the municipal and other governmental bodies be secured if the Institute is to serve the public to the full. Members can help by proposing new members.

The Council has furthered the development of an extension of the Royal Canadian Institute by branches in Hamilton and London. We have reached the stage where a definite plan has been called for and we hope that this work will be carried forward next year. I believe that a similar organization would be well received in many other cities in Ontario as well as in other provinces.

The Royal Canadian Institute looks back on a very successful year. I wish to extend my heartfelt appreciation to those who have made it so. To the members of the Council who have given me their cordial advice and active support; to those members who have contributed much to the furtherance of the work I give my best thanks. We look forward to a new year of service and helpfulness and trust that we may take whatever opportunity there is to help make this a better world.

Report of the Honorary Librarian

1941—1942

Continuing the policy of recent years, the effort during 1941-1942 has been to maintain the library in as useful and effective a condition as possible along lines already developed. A severely conservative policy, even had it not been felt wisest in the present conditions, has in fact been forced upon us by the allotment to the Library of only half as much time from the Executive Secretary and his assistants as in previous years. Only the loyalty, efficiency, and enthusiasm of Mr. Murray and Mrs. Rawlings have made it possible to keep the library from retrogression.

The importance of the library as one of the few direct, rather than indirect, ways in which the Institute supports and furthers scientific advancement has been urged in previous reports. It is difficult to make the members, who are mostly scientific laymen, conscious of this and yet it is very important that they should be brought to realize it if possible. There has been called to the attention of your Librarian a case of a member who had the Public Reference Library borrow a book from the Royal Canadian Institute Library for his use and was surprised and pleased to learn later that he could consult it more freely and comfortably in the Institute building. Most members, however, never have occasion to use the Library personally. They maintain it for the use of those engaged directly in active scientific work.

In order to try to make the members at large understand a little better the value and the use of a scientific library, your Librarian has forwarded to the Lecture Committee a suggestion that an effort be made to obtain one lecture next session on this subject from some prominent and technically trained speaker, who might possibly be procured through the American Special Libraries Association.

The expected decrease in the number of volumes requiring to be bound has not yet materialized, partly on account of the fact that the binding of some older items which had accumulated is being pretty well overtaken.

This year there were 276 books bound at a cost of $672.56, the sum of $600.00 having been set aside for binding purposes. Last year we had 246 books bound at a cost of $558.27.

285 books consisting of 588 volumes have been checked and catalogued after binding during the year. The corresponding figures for last year were 208 books consisting of 402 volumes.

20 books have been prepared for binding which will be bound next year.

The old sets of incomplete volumes stored at 198 College Street have been considerably reduced during the year. Seven sets were either sold or donated to other libraries; forty-six sets, only eight of which were completed, were placed in the various sections of the Library. It was concluded that we would be unable to purchase the missing parts for these incomplete sets as they have appeared on our dealer's list to purchase for over a year. There will, however, still be an effort made to secure the missing parts by purchase.

There are still nine other sets to be completed. In most of these cases we have written to the various societies from which we received the publications requesting that we be supplied with the missing parts. Although we have written a second and third time, our letters remain unanswered.

As stated in our report of last year, it is becoming increasingly difficult to secure foreign publications to complete our sets even through purchasing agents. This, of course, is due to the fact that we are confined to dealers on this continent only.

A sum of $41.05 was spent during the year on parts purchased to complete our sets and on some subscriptions which were considered to be of value to the Library. The amount set aside for this purpose was $100.00.

Our accessions have been decidedly decreased this year owing to the war. The number has been reduced from 709 in 1940-1941 (and 1009 in 1939-1940) to 612 in 1941-1942 publications now on our current catalogue. These periodicals are catalogued upon their receipt and filed in their proper places. Missing numbers are watched for, and if need be, written for. Unfortunately some of these requests go unheeded even after a second letter has been written.

Our Transactions and Proceedings were sent to 7 societies which subscribe to these publications, and to 338 societies which exchange publications with us. This is a decrease in number from last year of 44 societies and is due to the occupation by Germany and Japan of additional countries during the past year. As 164 societies had been cut off our exchange list during the year 1940-41, the additional 44 for the year 1941-42 brings the total up to 208 societies cut off since the war began. We have arranged 10 new exchanges during the past year.

Cards returned in acknowledgment of receipt of our publications have been checked off against the various societies.

Sets of our Transactions and Proceedings have been prepared and sent out upon request to 4 societies. These consisted of 39 parcels, averaging 4 lbs. each, which had to be wrapped, labelled, weighed, and mailed.

There were 73 publications borrowed from our Library in the Institute Building during the year by individuals, and 5 publications have been lent

to other libraries. We have borrowed 3 publications from other libraries. We are informed by the University of Toronto Library that, on an average, 1 publication per day is borrowed from our stacks at the University. It is also recognized that books are frequently consulted in the stack-room without being removed from it and no record is made of these nor of the books used in our reading room.

The number of volumes added to those in dead storage in the basement of University College was 874. These are sets of publications which are also to be found at the University of Toronto Library, the files of which are at our disposal at any time. These publications are packed in boxes whose contents are listed thereon, and thus preserved in the best possible way under the limited circumstances. It is felt that the Institute may sometime in the future be in a position to enlarge the shelving space of the Library and include these publications in its library proper. It is expected that many requests will come, as one already has, from scientific libraries in other countries where losses have been great owing to promiscuous bombing for any sets we are able to provide which will be of value in rebuilding their libraries. Many of these sets could be placed to advantage this way if the Institute sees fit to dispose of them when the time comes.

It has also been recommended to the Council by the Library Committee that the books in dead storage might be available to branches of the Institute in Ontario if such should be established at any time, ownership remaining with the central body or Council of the Institute.

We are continuing to dispose of various numbers of duplicate unwanted material. We have made a donation to the Academy of Science of St. Louis of 85 publications or sets of publications weighing approximately 200 lbs. This work required quite a lot of time as each requested publication had to be selected from our stacks of unwanted publications. In return for these, we had the privilege of requesting any of the duplicate material of the Academy of Science of St. Louis, a list of which was sent to us. As a result we were able to secure 9 publications, or sets of publications to help complete our files.

The Library of the Royal Canadian Institute is composed of 32,136 volumes, housed in three different buildings. They are divided as follows:

18,975 volumes at the University of Toronto Library.

10,877 volumes in dead storage in the basement of University College.

2.284 volumes at 198 College Street.

E. HORNE CRAIGIE,
Honorary Librarian.

Membership.

(1) Ordinary members are entited to all privileges of membership, the annual fee being five dollars. Applications for ordinary membership are passed upon at the regular meetings of the Institute.

(2) Associate members are ladies who do not desire full membership. They are admitted in the same way as ordinary members, the annual fee being two dollars and fifty cents.

(3) Life members are elected in the same way as Ordinary members, the Life membership fee being one hundred dollars.

For further information relating to membership or to the activities of the Institute, address letter to

THE SECRETARY,
The Royal Canadian Institute,
198 College Street,
Toronto, Canada.

The Saturday Evening Lectures

One of the objects of the Royal Canadian Institute is to further a popular interest in research. Since the results of research are so far-reaching in their effect upon the life of every member of the community, it is necessary to create an intelligent public who will be able to follow the work and achievements of those who are engaged in it.

What has been done in the past is illustrated by such important accomplishments as the invention of the telephone and the radio, the discovery of radium, the improvement of the telescope, also by the immense access of knowledge as to the structure of matter, whether in the atom or the universe, the manifold phases of life on the earth, and the exploration of the world.

The lectures of the Institute are the medium whereby such work is explained to the public. On Saturday evenings during the season, popular lectures of a scientific nature are given by men outstanding in their own field. The purpose is to interpret scientific research for the public.

"Canadian Frontiers"

L. JOSLYN ROGERS, B.A.Sc., M.A.

President of the Royal Canadian Institute.

November 1st, 1941.

John Keats concludes his immortal sonnet dedicated to the pulsing spirit of discovery, thus:

"Then felt I like some watcher of the skies
When a new planet swims into his ken,
Or like stout Cortez, when with eagle eyes,
He stared at the Pacific, and all his men
Looked at each other with a wild surmise,
Silent . . . . upon a peak . . . . in Darien."

Keats was an overwhelmingly great poet. Like every great poet, he was a visionary. And visionary that he was, Keats, standing on the threshold of the scientific age, saw the scientist and the explorer as one.

One may charge that the scientist does not suffer the physical discomforts or privation of the explorer. But the storm of opprobrium which broke around Darwin when he first published the "Origin of Species," must have been far more difficult to bear than the physical discomfort attendant to his trip around the world on the Beagle.

Times have changed. Today the scientist truly is monarch of all he surveys. His opinion is sought, his views respected. And yet one element, viz., rapidity of intercommunication, which has brought the almost frightening changes in the world today, is absent from the scientific world as we know it now.

The world of science has never been charted or mapped. Its frontiers are technological, bewildering in shape and substance, complex, difficult of comprehension. Intercommunication is difficult. Technicians who have every last detail of their own province of knowledge at their beck and call are in many cases woefully ignorant of what lies "over the horizon, and beyond the wave."

Borders between the multitudinous branches of science will ultimately be broken down, and a new and abundant life spring into being. Canada will share gloriously in its creation. The scientist burns with the spirit of the alchemist. He transmutes dull ore and brown soil into glittering gold and copious fields of grain. Canada, rich in God's manifold gifts of forest and field, will surely in the fulness of time become a nation mighty, rich and respected.

First and foremost, the scientist must preach a proper husbanding of our natural resources. His goal is maximum return from our natural resources. Scientists must plan with the precision and drive of a well-drilled team to reach that goal. They must base their offensive on that solid foundation of fact which eliminates error, and permits the delicate balance of nature to continue undisrupted.

This correlation of science to life is on its way. Science is certainly without value if it does not help us human beings. For your perusal, therefore, I close with the cryptic seven-point scientific Charter promulgated by the British Association for the Advancement of Science after its conference in September last.

This epochal Scientific Charter reads:

1. Liberty to learn, the opportunity to teach and the power to understand are necessary for the extension of knowledge, and we, as men of science, maintain that they cannot be sacrificed without degradation to human life.

2. Communities depend for their existence, their survival and advancement, on knowledge of themselves and of the properties of things in the world around them.

3. All nations and all classes of society have contributed to the knowledge of utilisation of natural resources, and to the understanding of the influence they exercise on human development.

4. The service of science requires independence combined with co-operation, and its structure is influenced by the progressive needs of humanity.

5. Men of science are among the trustees of each generation's inheritance of natural knowledge. They are bound, therefore, to foster and increase that heritage by faithful guardianship and service to high ideals.

6. All groups of scientific workers are united in the fellowship of the Commonwealth of Science, which has the world for its province and the discovery of truth as its highest aim.

7. The pursuit of scientific inquiry demands complete intellectual freedom and unrestricted international exchange of knowledge; and it can flourish only through the unfettered development of civilised life.

"Destruction and Reconstruction in Britain"

ERIC R. ARTHUR, M.A., B.Arch.Liv.

Professor of Architectural Design, University of Toronto.

November 8th, 1941.

When the spacious firmament on high opened, and death and destruction poured upon the green and pleasant land of England, a new era, a new and shining era in England's long history dawned. The vortex of war, it is true, has claimed much that is rare and old, and much valued for high reasons of sentiment and history, but it has claimed much that is sordid and ugly, inconvenient and inefficient. So from the ashes of the old, a new and shining England will rise.

The evolution of history has hitherto prevented any drastic housecleaning. For 200 years a few troubled men stood by and watched pleasant villages engulfed by a seemingly unappeasable urban monstrosity—the industrial city. Black smoke and hard cobblestones was the apparent heritage of the fresh English countryside, and nought could be done to stem the tide. But today, when the smoke of battle clears, England will roll up her sleeves and build a new England to replace the old.

Powerful commissions and committees are already pondering the problem. Coventry has, under a hail of bombs, built 2,500 houses since the war began. Legislation now enacted provides for the purchase of land by competent public authority, so that it may be used in the common weal.

Six permanent model towns built to the specifications and ideals of architects now grace the English countryside, and another 44 are nearing completion; and thus men and women engaged in industry can live in quiet rural surroundings within walking distance of their work.

But what of those moving and beautiful buildings wrought by a romantic past? Well, new times demand new things. No one will ever write a better mozartean sonata than Mozart. And no one will ever build a better English Rennaissance Church than Sir Christopher Wren or Inigo Jones. To tread in the steps of the master is a pale and profitless pastime, intellectually and artistically speaking.

For today a new concept of beauty, keyed to the machine, which is functional and smooth and swift and sweeping, has been evolved. Beauty, we believe, should be inherent in design. No longer is it necessary to gild the lily. But, withal, modern design is not designedly cold and harsh, a thing of steel and iron. Frank Lloyd Wright, leader of the romantic school of modern architects, designs his buildings to follow the natural

contours of the site on which they repose, and often makes use of materials found on the spot, like wood from the trees, and stones from the ground or nearby rivers.

So, when the rebuilding of London gets under way, the old must give way to the new. And still the old, speaking in soft accents of an antique day, will not be altogether silenced, for stately buildings like St. Paul's are still intact, and many of those which have been partially destroyed may be tastefully incorporated in a blending of the new and the old which will cast a historic aura over the new structure.

When the war is over, British architects will have the solid support of the public to begin and finish, in a suitable manner, the reconstruction of a new Britain.

"Science and Reconstruction in China and Eastern Tibet"

R. GORDON AGNEW, D.D.S., Ph.D., L.D.S.

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November 15th, 1941.

While the western world has watched with admiration the capacity of the Chinese to defend their country and their culture against the attacks of a ruthless invader equipped with all the armaments of modern warfare, and not even stopping short upon occasion of the use of poison gas, friends of China are often unaware of the fact that China is doing an almost incredible thing. She is on the one hand offering all-out resistance to the enemy and at the same time making vast strides in reconstruction in the physical development of her great interior provinces in cultural, moral and intellectual reconnaissance, all of which offers striking evidence to the world of the depth of character and the outstanding ability of her people.

The great co-operative movement has brought hope and sustenance to great numbers of destitute refugees and it has also helped to solve great economic problems in that far-flung country; it has helped to equip legions of soldiers for warfare and to meet unprecedented civilian needs. This co-operative movement interests and challenges western economists.

Following systematic destruction of colleges and schools in the coastal areas, many thousands of students and teachers, gathering from the smoking ruins of lecture halls and laboratories meagre supplies of books and instruments, have trudged weary hundreds of miles inland. They have

faced dangers of aerial bombardment, swollen unbridged rivers and mountain passes to reach the interior. Here, under unbelievably hard conditions, and in full accord with Generalissimo Chaing's urgent plea that higher education and training must go on, schools have reopened. One great university in the North-West holds lectures and laboratory classes in caves dug out of the mountain side. All over free China underfed boys and girls and young men and women are proceeding with their training until they are able to offer their services to their country in the capacities for which they are fitted.

Scientific work goes on with enthusiasm and efficiency as engineers build highways such as the Burma Road over seemingly impossible areas. Scientists penetrate right to the heart of eastern Tibet seeking mineral wealth for the nation, seeking food for hungry people, improving methods of agriculture, dairying, mining, etc. Teachers work into hitherto remote areas establishing schools for the young and offering adult training for the older people. University laboratories work day and night over problems of medicine and all the branches of health work in chemistry, physics, biology, engineering.

Far-sighted statesmen, economists, and religious workers, seek to lead the people into wider concepts of democracy and internationalism. They build upon the sound foundation of the traditionally democratic ideals of the Chinese people and are endeavouring to focus all of the surging life and shrewd thinking and the passionate activity of the people along such paths as will lead to a new and firm democracy, not only for China but for all freedom-loving peoples.

"A Naturalist in the South Seas"

K. P. SCHMIDT, A.B.

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November 22nd, 1941.

The Field Museum Expedition to the South Seas sailed in the private yacht *Illyria* of Cornelius Crane, patron of the expedition and scion of a trustee of the museum. Its objective was to visit little known archipelagos and rarely visited islands, to accumulate collections from little known regions.

First stop in the long itinerary from Boston to Borneo was historic Haiti, in the West Indies. Deep in the dank dungeons of the gloomy fortress of the negro Emperor Christophe, members of the expedition found

a handsome bell-voiced frog, which, unlike the frogs of the north, lays its eggs on land. The young undergo development in the egg without passing through the tadpole stage and hatch out as young froglets fully equipped to pursue the normal duties of life. Oddly enough, the tail is transformed into a breathing organ in the egg—an astonishing modification which almost makes us catch our own breath with wonder.

The expedition next visited the biological station on Barro Colorado Island in the Canal Zone, there to wander in the gloomy tropical forests and spot animals sporting the prehensile or grasping tail which is the hall-mark of the tropical forest. The sloth there found is surely the queerest of the queer. Born in a tree, growing up in a tree, feeding and dying in the crotch of a tree, and perhaps never coming to earth in all his born days, he, like the stone that does not roll, can be said to accumulate moss, for algae flourish in his hair; and again, like a fixed rug, moths inhabit his fur; when you shake him or beat him the moths fly out. Though there are many bright-coloured birds in these tropical forests, there are many dull-coloured birds as well.

Next stop was the Galapagos Islands. Galapago is a Spanish word meaning giant tortoise. When Darwin visited the islands a century ago, tortoises occurred in countless thousands on all the islands. Today they have been decimated, and are now extinct on some islands, scarce on others, and not really abundant on any of the islands.

A 3000 mile sail across the Pacific brought the expedition to the Marquesas Islands in the South Pacific. These are the islands described a century ago in Melville's "Typee," and visited in the eighties by Robert Louis Stevenson. It is thought there were 50,000 people living on the islands in Melville's time. Now the Marquesan race has declined to about 5,000.

The Society Islands, largest of which is Tahiti, were next visited. The near-by island of Moorea, with its lofty volcanic peaks, is one of the most beautiful spots in the entire world.

After crossing Polynesia, the Field Museum expedition entered the Melanesian island groups—the Fijis, New Hebrides, and Solomon Islands. The native Melanesians are strange people, difficult to deal with, and, in the New Hebrides, remain essentially uncivilized.

The expedition concluded with a visit to New Guinea, second largest island in the world, the western half and the interior of which is mostly unexplored. The expedition was able to reach a spot 400 miles from the sea on the Sepik River. There headhunters were encountered, and human skulls were the first articles offered as trade. It was a spot visited by white men only once before. There everything was different and the hands of the clock had been set back 100 years.

"What Use the Engineer Makes of Geology"

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November 29th, 1941.

Many people have for years regarded geology as a pure or descriptive science. Indeed some think of geology as nothing more than a study of fossils. And yet, in all its manifold applications, geology is becoming of greater practical down-to-earth use, day by day.

The reason for this is that the geology is there, and you can't change the geology. You have to master it, or humour it, or beat it at its own game. But you can't ignore it. You just can't. Because if you do, the bill will come in later.

The civil engineer will find some knowledge of basic geology a useful tool. He need not be an expert geologist, but he should have sufficient knowledge of geology to call for help when he runs up against a complicated case that calls for the attention of an expert geologist. In one case, many thousands of dollars were spent on a flood control dam, before they found the geology was all wrong, and they were forced to abandon the project. If a proper geological examination had been made, it probably never would have been started.

Then there was the case of the St. Francis Dam, in California. Height: 200 feet. Length: 750 feet. Five hundred foot wing wall along one side. A handsome looking dam. What was the matter with it? Well, the geology. On the farther side of the valley was a mica schist. On the near side was a conglomerate with a crushing strength of only 520 lbs. per square inch, pieces of which slaked in water. Those two rocks met under the dam. They were separated by a fault, and there was a mass of soft rock or gouge perhaps three or four feet thick along the fault line. One night, when the dam was completed, and nearly filled with water, it failed. A stream of water 120 feet deep rushed from the dam, moving at first at an estimated 18 miles per hour down to the sea. One "small" block of concrete weighing 10,000 tons was carried down the valley by the flood.

The catastrophe caused several million dollars damage. No geological examination had been made before the dam was constructed. The topography was all right. The geology was all wrong. And somebody had to pay the bill in that case.

Today engineers have pretty well learned their lesson, particularly on the larger projects. The foundations of such monumental works as Grand Coulee Dam and Boulder Dam are adequately geologized before the work proceeds. But if the engineer becomes incautious, or rash, even for a moment, he may find destruction, chaos and ruin visited upon his handiwork.

"The Peoples of Canada"

WATSON KIRKCONNELL, M.A., Ph.D.

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December 6th, 1941.

Two illusions commonly flourish in Canada. One is that Canada is a great geographical unity, the other that as a nation she is predominately British in origin.

Canada is really four reservoirs of settlement, projecting northward from the United States, and joined by long narrow pipe-lines labelled C.P.R. and C.N.R.; for the Maritimes, the St. Lawrence system, the Prairies, and the B. C. Coast, are peninsulas of settlement separated by rock and wilderness, largely uninhabited and uninhabitable.

Again, in respect to population, Canada is not a unity, and not Anglo-Saxon.

The oldest group in Canada consists of 3,500,000 Canadians whose origin is French. Most of our French population has been here from ten to twelve generations.

The second great group is the Anglo-Saxons, who number 5,500,000. Settlement by this group has come about for the most part in the last 100 years. The vast majority of this group are Canadian-born, though rarely of more than the third or fourth generation.

The third great group is that stemming from other great European stocks than those of the British Isles and France. These total today approximately 2,500,000.

So today, the French-Canadian group and what one might call the European group, added together, outnumber, and have outnumbered since 1938, the Canadians whose origins are in the British Isles.

A break-down of the European group shows we have today approximately 600,000 Canadians whose ancestors were German, over 300,000 of Ukrainian origin, about 250,000 Scandinavians, 170,000 Canadians of Jewish origin, 160,000 Netherlanders, 150,000 Poles, 110,000 Italians, 60,000 Russians, 50,000 Finns, 50,000 Magyars, 40,000 Czechs and Slovaks, 30,000 Rumanians, 30,000 Belgians, 10,000 Greeks—and the list might be extended in diminishing order to a score of other groups.

The whole is not static. Till 1840, Canadians of French origin were in the majority. By the time of Confederation, Anglo-Saxons totalled more than 60%. Today, in 1941, Anglo-Saxon Canadians have dropped to 48%, the French are stabilized at 30%, and the others total almost 22%.

It is estimated that owing to a differential in the birth rate, if present trends continue, the French of Canada will by 1871 outnumber the Anglo-Saxons. The Dionne quintuplets are harbingers of a new time. And yet Canadians of French origin are not unduly prolific. Rather, as figures show, the Anglo-Saxon population is not maintaining a survival birth rate.

Owing to political and economic problems of an international character, it is unlikely that, following the defeat of Hitler, there will be a large influx of population from the British Isles. Our diversity of national stock will therefore likely be permanent. Yet much enrichment of individual and national life can spring from diverse cultures in a single state. Says Lord Acton: "A state which is incompetent to satisfy different races, condemns itself. A state which labours to neutralize, to absorb, or to expel them, destroys its vitality. A state which does not include them is destitute of the chief basis of self-government."

It is true that in a vast number of cases our newer citizens have come to us from the peasant classes of central and eastern Europe. They were dealt, so to speak, from the bottom of the national deck. But in the relatively free opportunities of the New World the second generation and, still more, the third, have full control of the quality and capacity which may have lain latent throughout the long, unprivileged generations.

One year in the University of Manitoba, among the twelve students who stood highest in the freshman year, ten were of the New Canadian group, although that group represented less than half of the student body. At McMaster University, we have six open scholarships in mathematics, modern languages, English, etc. This year two of the six were won by Anglo-Saxons, one by a Czech, one by a German, one by a French Canadian, the sixth by an Italian; four of the six, here in Old Ontario, thus going to the newer groups among us.

These groups come to this country of ours, this land of free historic liberty, with dreams of a future, and a fuller life. Their children and their children's children will vindicate the reality of this Canadianism.

These groups are vitally aware, from close personal experience, just what it will mean if Hitler runs rampant over the earth. They are unanimous with us that it must be stamped out.

"The Chemical Descent of Man"

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December 13th, 1941.

The skeletal resemblances between man and the primates is most striking. But when one turns to chemical evidence of evolutionary relationships, he finds them more convincing because the correspondences often extend to minutest detail, amounting to identity with respect to a thousand particulars. Moreover, it relates man to the lowly lichen which grows on the stones in his garden, and to which he presents no resemblance in form.

Many of the most striking chemical comparisons among animals pertain to endocrinology. The glands of internal secretion elaborate definite chemical substances called hormones. These substances, carried through the blood stream, excite physiological function at some distant and appropriate point. The chemical structure and precise identity of many are still unknown though their existence and function is generally accepted.

The first of the hormones to be isolated was adrenalin, in 1897. Carried through the bloodstream of dog or man, it causes the hair to rise, increases blood pressure, strengthens and hastens the heart beat, constricts the blood vessels, and increases the sugar content of the blood. The animal is thus prepared for the contest which its emotion presages. Who can doubt that the more elemental emotions of man, mice and dogs, are derived from their common chemical inheritance and common experiences of evolutionary history?

This similarity of chemical control in mice, men and dogs, may be extended to many minute and particular points of physiology. The general results are the same, viz., to confirm the evolutionary aspect of man's history.

That man is chemically akin to the lower animals has long been known. However, owing to developments in the field of vitamins in recent years, we now have chemical evidence of the kinship of man to the plants, including the lowly yeasts, moulds and bacteria. The plants make the vitamins for their own use in their metabolic processes in ways which are very similar to those employed by animals. We have thus inherited from the plants the need for these complex and intricate chemical mechanisms, even though we have not inherited the ability to produce them for ourselves. These mechanisms are not only highly intricate but also highly specific. It is a marvel indeed to find that of all the thousands of substances which living things might have employed for such purposes the selections which have been made by all forms of life are identical. Man's

genealogy is thus traced back to the simpler cells of the types which must have existed millions of years before man's advent. The enduring quality of natural law is thus strongly emphasized. Nature appears always to have proceeded by adaptation of her earliest concepts rather than by new and revolutionary ideas.

But evolution plays a dual role. It is the mother of the human spirit. Her fingers shape not only the form of man's body, but also his mental acts, his economic laws, and his social institutions.

Granting that premise, we should have sense enough to be patient and no longer believe that we can revise human nature at a bound. The competitive contest for survival has been in progress for eons. It has served to eradicate inferior mechanisms which would otherwise contaminate our heredity. It is biologically absurd to suppose that competition or equivalent selective process can now be eliminated without certain retrogression of the human race.

That does not mean Nature refuses to sanction sentiment, aesthetic appreciation and spiritual values. She does sanction them for their survival value, otherwise they would not exist on top of the evolutionary scale. Mother love, and family, pack, herd, shoal, and hive loyalties, live in hundreds of Nature's humbler creatures.

Nature is a fickle mistress. Yet she is not unfathomable. Indeed, the study of biology as a foundation for statescraft, philosophy and religion, and, especially, social science, is much to be commended.

"Facts and Fallacies About Man"

H. A. CATES, M.B.

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December 20th, 1941.

The present is but the fleeting transitory moment, gone even as we think of it. The future is on the lap of the gods; no one may know it. The past, and the past alone, is of prime importance; it has determined our existence and makes us what we are.

At the starting point of any inquiry into the past lies the problem of the origin of life itself. No man can speak with authority on that point. Idle speculation is beside the point in the present narrative.

The next question is, how does life present itself under such a variety of forms? The ancient philosophers believed life sprang into spontaneous existence. Right through the middle ages all sorts of experiments were

performed to demonstrate this spontaneous origin of life, all based on misconception of natural laws hidden in the abyss of the future.

Toward the close of the 18th century, Lamarck, a French naturalist, propounded the proposition that animals came to vary as a result of functional demands and environmental requirements. The giraffe developed a long neck over the centuries by intensive effort to reach the succulent leaves at the top of the tree, etc. Experimental science does not bear out this theory.

The achievement of Darwin was to formulate a working hypothesis to explain variation. It has been modified since he propounded it. Its essence, however, like the atomic theory, is here to stay. Increasing knowledge serves but to support and strengthen it.

It is a well known fact that there is an inherent tendency of forms to vary. The word inherent lays emphasis on inheritance rather than environment. In that way it clashes with the Lamarckian theory.

These variations may occur in almost any direction, not always useful. Only those that in a given environment contribute to the survival value of the animal possessing them, tend to survive. That accounts at least in some measure, for the varieties of forms of life.

The next question is, what of the relationships that exist among various forms of life? The science of Taxonomy undertakes to classify and give names, and the tools this science employs are of course the structural affinities and structural differences to be observed among groups of animals.

It is a mistake to assume that the higher forms of life will necessarily have a more complex structure in all their parts, *ipso facto*, than the lower. A study of skulls from fishes, through reptiles to mammals, shows considerable simplification.

Life, it seems, began in the water. The human body consists today of 85% water, carried around in a waterproof envelope—the skin. It is surmised that the first animals left the water because the water disappeared, and certain types managed to survive on land. Thus rose the Age of the Reptiles. These horrifying monsters, many of which may be seen at the Royal Ontario Museum, went in for excessive specialization, and when a cataclysmic change of environment occurred, are presumed to have been wiped out. The mammals of the period avoided the excessive specialization and managed to survive.

There are several orders of mammals existent today. The duck-billed platypus is a mammal, as is the wallaby, the kangaroo, and the ant-eater. The most important order for us is the Primates, for man is a Primate, as is the lemur, the Orang-Utan, etc. The nearest ordinal relatives among the mammals to the Primates are the Insectivora. A tree shrew (Insectivore)

and a lemur (Primate) are very much alike. The lemur and tree shrew represent types nearer the basal stock than man and the anthropoids. That fact abolishes the bugaboo of the "missing link." As Darwin himself declared, there is no necessity or prospect of finding a form of animal ideally intermediate between modern man and one of the modern apes; the progenitor of both is a form considerably more primitive than either.

One of the most striking characteristics of the Primates is the shortening of the facial region, accompanied by restriction of the nasal cavity (inhibiting the sense of smell), and migration of the eyes toward the front of the head (providing stereoscopic vision). It accompanies increase in the size of the skull to provide for a bigger brain.

The primate limb is generalized and primitive, and not specialized as in the case of the horse. The primate foot is more specialized than the hand. In man the hand is very versatile and unspecialized and can thus perform a variety of functions, from playing the Paganini *Concerto in D* with consummate skill, to fumbling with delicate inprecision for a latch key after a stormy evening. That freedom of the hand has been conferred upon man by his erect posture, a distinguishing characteristic which sets him apart by a nobility of stature denied other enterprises of nature.

The glory of the Primate, however, is the development of the brain. The gorilla, weighing 500 pounds, has a brain weighing 500 grams. The human being, weighing 150 pounds, has a brain weighing 1500 grams—weight for weight, fifteen times that of the gorilla.

The brain is, in the last analysis, not an organ primarily concerned with mental processes, i.e. intelligence. It is primarily concerned with receiving stimuli from all parts of its own body, and from the external environment. It may be that it is in the increasing complexity of patterns of response to internal and external stimuli that "intellect" emerges.

Whatever is responsible for intelligence, it is not mere brain bulk. The brain of Anatole France weighed 1017 grams. Any brain of less than 1000 grams is regarded as scarcely human. Yet this was the brain of a literary genius.

When we consider the fact that man is now able in some measure to control his own environment, and thus stabilize one factor which has in the past led to variation and quick change, the idea presents itself that possibly man has at last reached the apex of his structural variation and evolution, and is now prepared to embark, with all the panoply and idealism, turmoil and strife in his being, upon the social and economic conquest of those problems which strike at the very root of his being. Social evolution is on the way.

"Rivers, Lakes and Fishing"

W. J. K. HARKNESS, M.A.

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January 10th, 1942.

We are all interested in stories about other parts of the world, of people, and their doings there. By the same token we are interested in the lives and surroundings of animals that live and have their being in a medium so different from ours. I am referring of course to the finny creatures of stream and lake. How do they live? What do they eat? What sort of life do they experience?

Their world is the water and in every body of water there is a community of plant and animal life, the members of which are in the closest possible association. The members of this community, although practically independent of life outside of the body of water, are interdependent, for in that community the basic food is vegetation or plants, just as it is with land-living animals.

The plants which are microscopic in size are present in countless millions and are known collectively as plant plankton. They are green or brownish in colour and, like land-living plants, require sunshine, so although they float freely in the water they are nearly all found in the upper 30 feet where the sunshine is brightest.

Swimming about freely in the water and feeding upon the plant plankton is a group of animals of which the individuals, although somewhat larger than the plants, include many that are microscopic in size. These animals are called collectively the animal plankton. Living and dying by countless millions the plant and animal plankters sink to the bottom of the lakes and there form rich pasturage on which flourish such benthic organisms as snails, clams, crayfish and the larvae and nymphs of many aquatic insects.

The fish which belong to the aquatic community are dependent on the other members for their food. They obtain this food by taking it into their mouths with a considerable amount of water, shutting their mouths and forcing the water out between their gills. The food would be carried out with this water if it were not that the spaces between the gills are covered by the gill rakers which resemble the teeth of a comb. The food supply of the fish is controlled by the nature of these gill rakers.

Those fish like the minnows and lake herring with very fine gill rakers placed close together feed on the plankton and are called forage fish. The whitefish, sucker and sturgeon have coarser gill rakers, more widely spaced, and they feed on the benthos or bottom-living animals. Finally that group

of fish including the trout, pike, maskinonge, bass and pickerel, have either short stubby gill rakers or none at all, and so feed mostly upon other fish. This method of feeding is associated with their speed and strongly developed bodies which make them the highly-sought game fish.

We thus see that in this community there is a food chain extending from the tiny plant plankton to the carnivorous game fish. This food relation presents what is known as a pyramid of numbers, the numbers in each link of the chain becoming progressively smaller from the millions of plant plankton through animal plankton, benthic organism, forage fish, to the relatively few carnivorous fish.

The life of the aquatic community is just as dependent upon the oxygen supply in the water as are land-living animals on oxygen supply of the air, and, just as on land, any excess of carbon dioxide is detrimental. Oxygen is present in abundance in streams and in the upper layers of lakes where it is released by the plant plankton or taken in from the air at waterfalls, rapids and by wave action. The oxygen supply is not so regularly abundant in the deep water of the lakes from which it is partially blocked by temperature stratification.

In midsummer the upper layers of water in a lake become warmed and light and will not mix with the large mass of cold heavy water in the bottom of the lake. During the winter when the surface of a lake is covered by ice there is no mixing of water under the ice. It is only in the spring and fall when the temperature of the water is the same from the top to the bottom that there is free mixing. As this is the period of equinoctial gales the surface is stirred up, much oxygen is taken in through wave action, and is carried into the deepest parts of the lakes. In the spring and fall it is said that the lakes take a deep breath.

Many species of fish, like the basses, sunfish, and catfish, are warm-water fish and live in the shallow warm parts of the lakes all summer. The cisco or lake herring is a typical cold water fish. As the season progresses from spring through summer and the surface water warms the ciscoes move in to the deeper cool water. In this movement the larger fish precede the medium and smallest fish by a period of two to four weeks. When they reach the deep cold water they cease feeding for a period of some three weeks after which they again feed normally. They remain in this deep water until the surface water cools in the autumn when they come into shallower water to spawn.

These ciscoes can live in lakes which have quite a small volume of deep cold water but if the water becomes too warm, if the oxygen supply runs out, or if the carbon dioxide becomes too abundant, they are killed out. The lake trout requires a much greater percentage of the water to be deep and cool for an adequate oxygen supply. It is for this reason that many lakes are not good lake trout lakes.

The lake trout is one of the most important fish in Algonquin Park lakes. The investigation of these lakes has been greatly assisted by the whole-

hearted co-operation of the anglers who have responded so generously in supplying Creel Census information about their catches.

It was found that the lake trout were very much like the cisco in their actions. In the spring they were taken in shallow water close to shore, but by midsummer the large lake trout could not be caught as they had gone into deep water and were not feeding. However, later in the summer these large lake trout in the deep water began to feed and could again be caught. The medium-sized lake trout, following the same pattern, disappeared from the shallow water after the large trout and began to feed in the deep water after the large trout had been feeding.

It was found that both the trout and the bass grew faster in some lakes than in other lakes. The rapid growth of lake trout was associated with the presence of the cisco, which served as food for the lake trout. It was also learned that some lakes had a large number of small and medium-sized fish, whereas other lakes contained a small population of large fish.

Information of this kind comes to light as the result of continuous research and investigation which is being carried on by many workers. Such information can be used in drawing up plans for the maintenance of our fishery resources at peak production. It is the purpose of fisheries research to establish productive fisheries in the water areas of the Province. Important as this work is in peace time, it becomes even more essential in war time when the water areas of our Province should be as productive of useful crops as our land areas.

"Production and Testing of Mechanized Transport"

R. J. RENWICK, B.A. Sc.

Engineer, Ford Motor Company of Canada.

January 17th, 1942.

Mechanized transport is the movement of men and material by mechanical means for military purposes; in contradistinction to the movement of supplies by animal power which has prevailed in the past.

Canada is the chief source of automotive material in the Empire, for the Empire. Military vehicles are truly tools of war, able to assist in dealing telling blows against the enemy.

Only since the First World War has military mechanized transport come into its own. It has revolutionized military strategy and tactics.

This mechanization is the result of serious thought and planning. The symbol of war today is not the sword, but the slide rule. Victory is largely dependent upon the balance of mechanization between ourselves and the Axis powers. Industrial production from this continent will eventually provide the mechanical superiority which, with British courage and determination, will sweep our enemies off the earth.

In Napoleonic days, per capita weight of an army was probably less than 500 lbs. per man. The gross weight of a Canadian Army Corps of two divisions is approximately 60,000 tons, including men, equipment, vehicles, guns, ammunition, food, fuel, and other essentials. Thus the aggregate weight of a soldier has increased fourfold in the past century.

A mechanized army is mobile, manoeuverable and swift to strike, as was ably demonstrated by our recent successes in Libya, but the task of mechanizing an army is prodigious. A fully equipped unit will have one mechanized unit for every four or five men. Canada has produced vehicles which have proved their worth in actual performance in Australia, India, New Zealand, Malaya and Libya. Reports of their work under battle conditions have been most commendatory.

Three times as tough as a commercial truck! That is the engineer's yardstick for these military vehicles. Short wheel-base, large wheels, excellent articulation, must be built into army trucks and vehicles. These vehicles, snubnosed, angular, dull, flat-coloured, are built to exacting British Army standards, and designed for rugged service rather than annual sales appeal. Practically all are four-wheel drive, and the front wheels must be capable of being steered either to the left or to the right, which necessitates the use of universal joints of the constant velocity type in the front axle drive shafts.

As far back as 1936 the automotive industry of Canada had been working on the problem of supplying military vehicles in time of war. Thus in a relatively short time after the outbreak of hostilities, the industry was ready to step forward and work for victory. In a Canadian Army Corps, approximately 15,000 units of various types of wheeled and tracked vehicles will be required. At the present rate of output, an army corps can be equipped in forty days.

The industry is today producing no fewer than ninety types of mechanized transports on twelve different chassis. There are universal carriers, wireless and personnel trucks, load carriers, ambulances, field workshops, staff cars, folding boat equipment, refuelling tenders, pole derricks, engineers' lorries, twelve varieties of field workshops, three styles of wireless trucks, and at least three fire trucks or aircraft crash tenders, all with a specific function and a needful purpose.

Canada is straining every sinew to turn out the tools for victory.

"War's Third Dimension—Morale"

J. D. KETCHUM, M.A.

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January 24th, 1942.

Modern war is three-dimensional. It is fought in the military, economic and psychological spheres. The latter has become of increasing importance with the spread of war to include the whole civilian population.

The essential elements in morale are, first, a goal, and secondly, courage in pursuit of the goal. We have a great common goal in this war; so if our morale fails it will be because of lack of courage. Courage, however, is not an individual thing, but almost entirely social; it is part of the larger and prouder self which appears when we identify ourselves with others, with our family, our regiment, our nation. Those elements in Canada whose morale is open to criticism are precisely the ones who have not been encouraged and aided to identify themselves fully with the country.

There has been much criticism of Canadian morale in general, chiefly because of mistaken comparisons with the attitudes of 1914. Attempts to arouse an intense emotional participation have had very little success, and fail to take into account the fundamental social changes which have occurred since 1914. Some of the most important of these are as follows:

(1) We are better educated. The average Canadian has three years more schooling than he had in 1914. He is more critical.

(2) American influence is far greater, and it is difficult for us to get more stirred up about the war than those across the border.

(3) Twenty-five years of high pressure advertising has left us relatively immune to propaganda, as compared with 1914.

(4) Moral sanctions have been greatly weakened, especially in international relations. We no longer get morally indignant over Hitler's aggressions and misdeeds.

(5) War as such has become more than ever morally repugnant to us. We accept it because it is inevitable, but we do not identify ourselves emotionally with its destructive ferocity.

(6) The frequent changes in national alignments put a premium on realism as against emotional fervor.

(7) The decay of community life and the substitution of the institutionalized contacts of the large city have removed the very basis of traditional morale. Warlike spirit no longer spreads contagiously from person to person; each tends to mind his own business. In the modern world leadership is left to the functionaries appointed for the purpose, so that there has been a great decline in individual initiative. Our motto is "Let George do it."

We should not expect in Canada a recrudescence of the emotional upsurge which marked 1914. That was a "virginal morale," and it has been lacking in almost all warring countries this time. A more mature type of morale is, however, steadily forming in Canada, aided by the following factors:

(1) An increasingly clear perception of the hard facts of the situation.

(2) The re-birth of the community as a result of growing war restrictions and hardships.

(3) The fact that more and more people are actually participating in the war in some way. When that occurs their thoughts and feelings soon fall into line. Our efforts should be, therefore, to give every individual something meaningful to do for the war every day; his morale will then take care of itself.

"First Aid in War Time Emergencies"

J. HAROLD COUCH, M.A., M.B., F.R.C.S.

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January 31st, 1942.

In first aid, as in any other emergency, the psychological attitude of the people concerned can spell the difference between success and failure. Like the Levite of old, one's first reaction, when confronted by an injured person, is to pass on the other side.

The attitude of the Good Samaritan is decidedly more commendable and refreshing. He offered aid, whatever he was able to do. He bound the man's wounds, pouring in oil and wine, and dressed them. He then arranged for transportation, taking him on his ass to the nearest village, where he arranged for hospitalization, paying the hotel bill so as to allay anxiety. All that was done is good first aid practice, but while pouring in oil and wine one must be careful not to include lockjaw and gas gangrene bacteria, which are commonly found in road dust.

The first and ever-present condition in any accident of any sort, is shock—which is not to be interpreted as meaning fear, anxiety, fright, worry, etc., but a definite surgical condition which can be at times so serious that people die of it. It is produced by pain, damage to tissue, exposure to cold, fatigue or anaesthetic.

The patient in shock presents a definite picture which varies all the way from slight transient nausea and tremor to complete collapse and death. When one sees a man who has been hurt, and says "that man looks bad" one is describing a man suffering from shock.

The patient in shock has hands and face somewhat blue in colour, with cold perspiration standing out on the forehead and lips. The pulse is rapid, the blood pressure low, the temperature below normal. All bodily processes are depressed and must be supported.

Treatment of shock is a matter of common sense. First, look to the comfort of the patient. Do not handle the patient in shock unnecessarily, keep him comfortable in every way possible, give him a cigarette if he wants it, keep him recumbent, and so on.

Second, maintain warmth. Cover the patient to protect him against cold. In fall or winter, cover him underneath as well. Supply extraneous warmth by hot water bottles or hot bricks, being careful not to place these next to the skin as the patient in shock is easily burned.

Third, administer fluid. The best fluid is hot tea or hot coffee. Each contains caffeine, which is a stimulant, is hot, and should contain sugar, which provides badly needed energy food at a time when the vital processes are depressed.

Pin a note on the patient telling what has been done, if he is able to be sent to a hospital.

Treat wounds so as to prevent the entry of bacteria. Cover them immediately with a surgically sterile dressing if available. A good makeshift dressing is the inside of a clean linen handkerchief, or the inside pages of a new book, torn out and placed right over the wound. It is not advisable to change dressings frequently, as this only facilitates the entry of bacteria.

Wounds are often accompanied by hæmorrhage. A small hæmorrhage is one which does not endanger the life of the patient. In such a case, treat the wound and ignore the hæmorrhage.

A large hæmorrhage may be a very serious matter. Internal hæmorrhage is sometimes difficult to diagnose. Such a patient presents the appearance of a person losing blood. The face is white, rather than blue or gray as in the shocked patient. There may be cold perspiration on the forehead and lips, and the pulse may be rapid, as in the shocked patient. But there is this difference. Loss of blood causes the victim to feel he is smothering. He feels he is not getting enough oxygen. He wants the windows opened, etc. The oxygen is present, but there is not enough blood to carry it to his head.

Persons suffering from fracture, should be treated for shock, have their fracture splinted, and be transported with a minimum of handling to a hospital. Often a truck is more effective as an ambulance than a motor car.

First aid for the drowning sometimes involves artificial respiration. A valuable consideration when effecting the rescue is the safety of the rescuer. Often a less spectacular but more cool-headed rescue is to be advised than plunging head on into the water in a "do or die" attempt to save a life.

"Developing the Athabaska Oil Sands"

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February 7th, 1942.

The "tar sands" of the Athabaska region in northern Alberta contain at least 100 billion barrels of oil, according to estimates by the Dominion Mines Branch, which is more than the proved reserves of all the other known oil fields of the world.

The sands are an ancient delta or estuary deposit washed into a shallow sea millions of years ago and later buried beneath hundreds of feet of sediments washed into the sea and in time consolidated into sandstones and shales. At some time and in some manner about which there is much doubt, the sand of the deposit became saturated with heavy, tarry oil. More recently the Athabaska River and some of its tributaries have cut valleys through the overlying rock and through the oil sands themselves, and left benches or terraces of the oil sands, some of them of large extent, along the valley walls.

Many of the terraces can be mined by open-pit methods, first stripping off some clay and gravel overburden, and the billion or more barrels of oil they contain is of immediate economic importance. The remainder of the huge deposit would have to be won by underground mining, at a cost too great for profitable development under present conditions, but the accessible deposits contain more oil than has been found in the rest of Canada.

The oil as recovered from the sands is a thick, black, viscous semi-liquid, only a step from pure asphalt, but when subjected to a moderate refining temperature for a moderate length of time it is converted or "digested" into a much lighter crude oil, which can then be refined into gasoline, naptha, diesel fuel, fuel oils, a whole range of asphalt products, and coke.

The first record of the deposit was in 1719 when an Indian called Swan showed a sample of the oil sand to a Hudson's Bay factor at York Factory. Peter Pond saw the deposit in 1778. Alexander Mackenzie saw it in 1788 and mentioned it in his book published in 1801. Later explorers, traders, trappers, and geologists mentioned or described the striking phenomenon. In 1913 Dr. S. C. Ells of the Dominion Mines Branch began the first systematic work and carried it on for twenty years. In 1922 Dr. K. A. Clark of the Research Council of Alberta began systematic work on the separation of the oil from the mined sand. Altogether the Dominion and Alberta Governments have spent more than $250,000 on oil-sand studies.

Meantime private enterprise has gone quietly ahead to make the oil in the oil sands commercially available. The job has not been an easy one. Three major problems had to be met: how to mine the sand cheaply, how to separate the oil from the sand cheaply, and how to convert so heavy an oil into merchantable products. International Bitumen Company began work in 1922, and although the plant is not in operation today, to it must go the credit for the first commercial production of refined products.

Abasand Oils Limited started laboratory and pilot work in 1930, and six years later it started construction of a small commercial unit on Horse River, a tributary of the Athabaska, 2½ miles from the end of steel and the steamboat wharves at Waterways. In overcoming the problems inevitably encountered in doing something never done before the company has spent nearly a million dollars. Its plant was in operation from last May until late November, when fire destroyed about half of it. Rebuilding is under way, and operation will be resumed early in June.

During its six months of operation the company made and sold gasoline, diesel fuel, fuel oil, and coke, all of which received high praise from their users. Because of the demand for these products, the company was unable to make any asphalt or road oils, which it is equipped to make to exact specifications and of high quality.

A few changes in equipment and method are being made in rebuilding, though none in fundamental processes. The method of operation here described embodies these changes.

The sand body being mined is about 35 feet thick, and was originally covered by an average of about 12 feet of clay, sand and gravel. This overburden is stripped off by steam shovel and trucks or by carry-all scrapers. The oil sand is then shattered in place with dynamite, picked up by steam shovel, and loaded into carry-alls hauled by tractors. These take it to the separation plant.

The separation of the oil from the sand is done in three steps. First oil, which is a clinging film enveloping each grain of sand, is broken loose by being tumbled about in hot water. The result is a pulp of sand and water and scattered particles of oil. The process is so conducted that the pulp also contains a multitude of particles of air. Then the pulp goes to specially designed flotation cells where the oil forms bubbles with the air particles and floats to the surface as a froth. Finally the froth, which contains considerable quantities of water and sand, is diluted with naphtha, which makes the oil so light that the sand and water quickly settle out. The diluted oil then goes to the refinery, where the naphtha is recovered and returned to the separation plant to be used again.

The first step in refining the oil is to digest it by heating it for half an hour or so in a "soaking" chamber. The rest of the refining is done by conventional methods in a pipe still and a battery of shell stills, with the

usual complement of bubble tower, treating units, gas traps, condensers, and coolers.

The liquid products go to the railroad and the steamboat wharves by pipe line; the solid products go by truck.

The new mining and separation units will have a capacity of about 600 barrels a day, and a few comparatively small changes in the refinery will bring it up to the same capacity. This output will be adequate to supply the gasoline, diesel, and fuel oil requirements of the North and most of the highway asphalt requirements of the northern half of Alberta. The main purpose of the present plant, however, is to serve as a guide to much larger operations the company has in mind, to produce some 10,000 barrels of digested crude a day on the Athabaska, ship it to Edmonton, and there convert it into refined products to help meet the need for an increased supply of petroleum products on the Prairies.

"What is a Metal"

SAUL DUSHMAN, Ph.D.

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February 14th, 1942.

With the exception of mercury, all common metals are solid at normal temperatures. They may be polished to exhibit high reflectivity. Some, like copper and gold, possess distinctive colours. They possess relatively low electrical resistivity and high thermal conductivity, characteristics which extend to mixtures of metals, which are called alloys. Most metals have appreciable tensile strengths, are often ductile, especially in the pure state, and can be drawn or rolled.

The most important fact about metals is that any desired range of cohesive properties may be obtained by alloying one metal with one or more metals, and subjecting the mixture to proper heat treatment. Aluminum and iron alloys (steel) are very important.

Metals and alloys crystallize in more or less regular geometric forms, a characteristic especially noticeable in cast ingots. More frequently these structures are revealed under magnification of 50X to 2000X, and a preliminary etch is required to bring out crystal boundaries. This crystalline structure results from the fact that individual atoms constituting the metal or alloy range themselves in definite lattice structures, or patterns.

A large number of metals occur in two or more different crystal lattice forms. This is known as allotropy. Each type of crystal structure exists

over a certain range of temperatures, and at certain critical temperatures there is a transition from one form to another.

Variation in properties of metals is actually due to differences in number and mode of distribution of electrons within the atom. In a typical metal such as sodium or copper, the cohesive energy is due to attractive forces between the free electrons and to the positively charged cores which are located at the lattice points. On the other hand, in the case of metals such as iron, chromium, nickel, and so forth, the binding forces are partly of the same nature as in copper and partly of the same nature as the valence forces between carbon atoms in diamond. It has been found possible to interpret a large number of metallic properties in terms of this electronic theory of metals. A striking example is furnished by the fact that we now have a theory of ferromagnetism which is much better than was available in the past.

Until the past two decades, metallurgy was largely an empirical branch of knowledge—that is, knowledge was obtained by the method of "cut and try."

With rapid developments in mechanization, represented by the automobile, the Diesel engine, a high pressure steam turbine, it became increasingly evident that further progress could be obtained only by intensive research on scientific lines.

It is largely by reason of such research that we have the high speed locomotives of today, lighter and yet more powerful than those of 20 years ago, and automobiles of which the cheapest available until recently is beyond comparison with the most expensive ones that could be bought a dozen or so years ago.

Therefore in the past 20 years, metallurgy has emerged from its position as an empirical art and become a more quantitative branch of science, wherein the physicist may explore its mysteries in the light of electron configurations of atoms as we know these today.

"Aircraft Production in Canada Past, Present and Future"

RALPH BELL,

Director-General Aircraft Production, Ottawa, Canada.

February 21st, 1942.

It is doubtful if any country in the world today has a better diversified aircraft programme than that of Canada; certainly no country of its population can even remotely compare with what is being done here in this important field.

Primary, intermediate and advanced trainers—each the best of its class anywhere; fighter, dive bomber, bomber and coastal reconnaissance amphibian—each the finest in the world, being built in a single plant which in many instances were specially designed for the particular machine in question: that is Canada's aircraft programme—with every plant booked solid at least until the end of 1943, and some into 1944 and even 1945.

Total volume of aircraft orders in Canada today is substantially over $500,000,000. The job now is to procure, schedule and distribute with an even steady flow the multiplicity of parts and materials necessary for so complicated an undertaking. If the manner in which similar problems have been handled in the past is any criterion, it can confidently be stated that all contingencies will be met in a thoroughly satisfactory manner.

Today Canada's aircraft industry occupies 5,000,000 square feet of floor space, employs 40,000 men and women, and produces far more planes in a week than were produced in a year before the war.

A key point in Canada's aviation history is October 1, 1907, when at Baddeck, Nova Scotia, Doctor Alexander Graham Bell, inventor of the telephone, met in association with J. A. D. McCurdy, F. W. "Casey" Baldwin, Thomas Selfridge and Glen H. Curtiss to form what was known as the Aerial Experiment Association. Funds for the undertaking were provided by Mrs. Bell, and without her vision and sacrifice—for the funds she contributed represented practically all her financial worth—the spectacular results from which those participating have received undying fame and credit would probably never have been realized.

Seventeen months after the formation of the association, the first heavier-than-air machine to fly in the British Empire—the "Silver Dart," with McCurdy at the controls—made its initial flight off the ice at Baddeck, Nova Scotia, on February 23, 1909.

However, a tremendous amount of basic research in aerodynamics had been done prior to 1907 by Wallace Rupert Turnbull, also a Canadian, who

built the first wind tunnel in Canada, and invented an electrically controlled variable pitch constant speed propeller which is today being built in enormous quantities in the United States and England.

In 1916 McCurdy—pilot of the "Silver Dart"—scored another first when he established at Toronto the Curtiss Airplane and Motors, Ltd., first organization in Canada to build aircraft on a commercial scale. Later in the war, a succeeding company, Canadian Aeroplanes, Ltd., was formed by the Imperial Munitions Board.

Following the close of the war, manufacture of aircraft in Canada ceased completely, but in 1923 Canadian Vickers commenced production on eight single-engined amphibians for the Canadian Air Board. Today the same company produces the Stranraer flying boat for coast patrol work, and is engaged in preliminary work leading to the construction of the famous PBY amphibian—one of which was responsible for apprehending the Bismarck.

In November, 1934, Noorduyn commenced design of the Norseman at Montreal, manufacture commenced next year, and the design has proved so useful that the United States has recently purchased several of these planes for special work.

Today, owing to the enterprise of Robert J. Magor, a courageous and far-sighted Canadian industrialist, who envisioned the impending conflict and prepared to cope with the situation, one of the most modern plants in the world is nearing completion at Malton airport, near Toronto.

No article on aircraft production in Canada would be complete without reference and tribute to the part that woman plays in this vital industry, which had its very genesis in the mind of a wistful-eyed little woman in the Cape Breton Hills a third of a century ago.

From a mere handful at the outbreak of the war to well over 3,000 today; from a seamstress stitching a fabric on the wing of an elementary trainer, from a secretary in an office, from a rivetter on a cockpit cowling, or a welder at the bench, to chief engineer of the Fort William plant, employing 4,500 men and women—women play, and will continue to play, an increasing part in this great Canadian industry.

Orders now on hand for Canadian aircraft total substantially over 10,000 aircraft, which, based on the comparative population of the two countries, is the equivalent of 120,000 planes in the United States.

An industry which in the short space of two and one-half years has been able to expand its personnel over forty times, and its output over eighty times and all that in the face of the difficulties inherent in a situation where building expansion and equipment scarcity is the order of the day is one in which Canadians may well have confidence.

"Songs of Wild Birds"

PAUL KELLOGG, Ph.D.

Assistant Professor in Ornithology, Cornell University, Ithaca, N.Y.

February 28th, 1942.

The songs of wild birds have always had a peculiar fascination for man. Donald Duck is never more enjoyed than in his wildest, most frustrated moments. And the poets have always had a keen ear for a bird in a wooded dell.

Such pleasure must remain a very individual matter, by reason of the time, trouble and money involved, unless some means might be found of making easily available to the multitudes the songs of the birds as they are poured forth in their native haunts.

The answer to that has been supplied by an ornithological group at Cornell University, who in 1929 began to work on the problem of recording the songs of hundreds of the feathered songsters, under the aegis of Albert R. Brand, an amateur ornithologist with an intense interest in his hobby, and a taste for financing the venture. Much of the field work has been done by Dr. A. A. Allen and Dr. Paul Kellogg.

The Cornell group began chasing birds from Cornell down through Florida, across to Texas, out through Oklahoma, to California, back up north, across the northern part of the United States, and home. They have even chased the rare ivory-billed woodpecker right into his lair in the deep swamps of Louisiana.

The songs of the birds are collected with a big "ear trumpet" which can be focussed on the individual bird and will amplify the song of the bird, for recording purposes to six hundred times the volume normally obtainable at the point where the "trumpet" or parabolic disc is installed.

The recordings are made on film which can later be converted into the usual disc recordings. The American Foundation for the Blind is intensely interested in the work. There are now obtainable, for general use, six recordings, double-faced, containing the recorded songs of seventy-two different North American birds. And if you are keen on bird music, and have a good ear, the songs of about a dozen extra birds may be heard in the background—thrown in for good measure. Information regarding the recordings, which have been produced by the Cornell University Press, may be obtained from the University direct, or from the Secretary of the Royal Canadian Institute. The recordings deal in the main with birds of the northern woods, that is, of the northern parts of the eastern states; and many of the birds will be familiar to Canadian naturalists, because birds are no respecters of boundary lines or custom inspectors. It is hoped that extensive recordings of the birds in certain sections of Canada will soon be made, possibly in the James Bay region, where many game birds congregate.

"The Royal Canadian Mounted Police"

V. A. M. KEMP.

Superintendent Commanding "O" Division, Royal Canadian Mounted Police, Toronto.

March 7th, 1942

The North-West Mounted Police was established in 1873 to create law and order in the Canadian West. The direct cause was the first Riel or Red River Rebellion of 1869. Following suppression of this rebellion, a force to control the huge territories was an inevitable sequence.

For nearly half a century activities of the force were restricted to Western Canada. In 1920 the Government, deeming a force with Dominion-wide jurisdiction and centralized control a Dominion asset, amalgamated the R.N.W.M.P. with the Dominion Police (the Government police operating in Eastern Canada) and, fused under one control, the two forces became known as the Royal Canadian Mounted Police.

The force occupies a similar position in Canada to that which the F.B.I. occupies in the United States, or that which Scotland Yard—which under certain circumstances can extend its jurisdiction over all the United Kingdom—occupies there.

In six provinces—Alberta, Saskatchewan, Manitoba, New Brunswick, Nova Scotia and Prince Edward Island—the R.C.M.P. operate under the provincial Attorney-Generals to enforce law and order as represented by the Criminal Code, together with the provincial statutes. This is done by virtue of special arrangement with the governments of the provinces cited.

The R.C.M.P. prides itself on the extent of its co-operation with local police in the Dominion. This co-operation is reciprocal and is of inestimable value to both parties.

At present, all men volunteering for service with the R.C.M.P. volunteer for service overseas with the R.C.M.P. Provost Company of the First Canadian Division. Men are carefully selected for character, education and personality. Service in the force is a career, not a job. The organization has an esprit-de-corp which guarantees smooth team-work. Officers carry the King's Commission (as in Navy, Army and Air Force)—and so far as is known, it is the only police force in the world so honoured.

Today, the problems of war are paramount with the force. Industry must be guarded against sabotage. Enemy aliens must be placed under surveillance. "Secret Service" work must be carried on. All this is the work of the force.

As usual, the force carries on in the Arctic. One-third of Canada lies in the Northwest and Yukon Territories; an area of one and a third million square miles. In this vast hinterland there are 10,000 souls, mainly Eskimo and Indian. The force is responsible for law and order in all its aspects. In addition, it collects taxes, radio fees, registers vital statistics, acts as postmasters, coroners, magistrates, visits and tends the sick, feeds the destitute, and occasionally buries the dead. The winter patrols in this region last year totalled 42,000 miles.

Scientific investigation is another activity which is becoming increasingly important in police work. The modern criminal fortifies himself with science, and must be overcome by scientific methods. Photography, fingerprint work, ballistic studies, fluoroscopic reactions, chemical analysis, hair and fibre examinations, tests for poisons, etc., are carried out on an ever increasing scale.

The force has pioneered in Canada in the use of dogs for police work. The majority of the dogs employed are German shepherds, quick and alert, possessed of uncanny powers, and yet under perfect control of their mentors.

To bring to a higher pitch co-operation between the various police forces of Canada, the R.C.M.P., publishes a co-ordinating journal—the *R.C.M. Police Gazette*—and makes its very comprehensive and elaborate courses in police work available to any force in Canada which desires to send representatives to the Canadian Police College at Ottawa.

In all its work, the force has endeavoured to live up to an enlightened view of police work. The policeman is the friend of all honest and upright citizens, just as he is the implacable foe of the lawless. Tact and firmness, courtesy and impartiality, are the touchstone of police work today.

The motto of the force, it might be noted, is not the generally quoted "Get your man"—a phrase which, while it has its romantic aspect, and has served to embellish many a fanciful tale—should be compared with the staunch integrity of the original and true motto of the force, which typifies police work at its best: "Maintain the Right!"

"Forestry and Pulpwood Forests"

R. W. LYONS, B.Sc.F.

General Manager of Woodlands. Kimberly-Clark Corporation, Neenah, Wisconsin.

March 14th, 1942.

A few years before the middle of the 19th century, a mill located at St. Andrews, Quebec, made the first paper from pulpwood in Canada. That marked the beginning of a process, and in 1887 the first modern pulp and paper mill was established at Grand Mere, Quebec.

Since that time growth of the industry has been phenomenal. In 1940 103 pulp, pulp and paper, and paper mills were operating in Canada. The pulp and paper industry has, since 1920, headed the list of Canadian industries in net value of production; and since 1925, in gross value of production. In 1940 the capital invested in the manufacturing part of the industry was $643,000,000.

The total production of all mills amounted in 1941 to 10,000,000 tons of material, valued at nearly $400,000,000 (estimated).

This industry exports pulpwood products and paper valued at $260,000,000—or 1½ times the total gold production of Canada.

Products of the industry are used in the manufacture of the following war material—shells, high explosives, naval mines, land mines, London detectors, radio equipment, hospital supplies and containers.

This huge industry is ours because of our heritage, which may be summarized as cheap hydro-electric power and pulpwood forests.

Such forest areas are still vast, especially in Canada. But so were the white pine forests of Canada, New England and the Lake States forty years ago. It is evident that the white pine forests were exploited like the ore of a mine and dwindled to a very small remnant.

In the pioneering days of Canada, it was necessary to open and clear the land and naturally forests were destroyed to meet a greater need. Further, low priced lumber was essential to early community life. Nevertheless, lands absolutely unsuited for agricultural purposes were left devastated, and will be unproductive for generations to come.

Today, knowing what may result if we pursue the wasteful practice of the past, we are bound to employ every means at our disposal to improve our forest heritage, and place it in the best possible producing condition.

The fundamental tool in carrying out such a project is forestry, which may be defined, with respect to Canada, as "The use of land to produce crops of timber after a manner similar to farm crops, or putting in order, and keeping in order, a forest business."

In eastern Canada the pulpwood forest consists of two main merchantable species—spruce and balsam; and to a more limited extent, jack pine. Mixed with the spruce and balsam are trees of lesser value—birch, poplar and maple, present in smaller quantities, and to be regarded as weed species, when they occur in pulpwood stands. Spruce is generally more desirable than balsam, because the yield of pulp per cubic foot of pulpwood is appreciably higher.

The problem is to establish favourable types of forest stands in forests being cut for pulpwood. To do this successfully—and yet economically—requires a technique which must be worked out in detail after preliminary investigative work. This requires research into the habits and characteristics of the different pulpwood species—the spruces (red, white and black) and the balsam.

This does not mean the adoption of European forestry practices or revolutionizing our logging methods. It means simply that we must apply the knowledge we now have in a scientific attempt to produce the desired species.

One of our great national errors is the assumption that nature made the forests we are now cutting and that, if fire is kept out, she will provide forests in the future. In this country, where most of the land is suited only to growing timber, and where the greatest crop is spruce, there is a great lack of definite knowledge relating to our forests. Forestry should command the same serious attention we give to agriculture.

"Medicine Marches On"

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Professor in the Faculty of Medicine, University of Montreal.

March 21st, 1942.

What is the future in store for medicine? There will be vast changes, that is certain. The rapid change in our economic and social life will see to that.

There is coupled with that the ever-present tendency for increased specialization in medicine, as in other branches of science, and there will have to be a proper balance between the general practitioner and the specialist, so that ills and ailments of mankind can be brought into focus.

Then there is the new democratic order which grows about us every day. Yesterday the doctor's concern was with the individual. Tomorrow

it will take a wider field. Preventive medicine is the medicine of the future. Prevention of epidemics, of disease, wherever it is found, in factories, in cities, throughout the nation, throughout the world, in collaboration with medical men the world over, working to a common purpose. Such is the lofty future before medicine.

Today the doctor exercises a quasi-dictatorial authority over the individual in his charge. Tomorrow with the elaboration of legislation designed to circumvent disease, the doctor will occupy a quasi-dictatorial authority over certain aspects of our community life.

Then there is a new science, now in the throes of full creation, which will require the skill and knowledge of the practitioner for its administration; it is the science of differential biometry, which will make it possible to state, in definite terms, why one man, medically normal, is different from another man medically normal. It will point out the range and extent of those differences, and enable a forecast as to occupation for which individuals are best suited, etc.

The physician entrusted with this work will have an intensive knowledge of biology. He will know the body of man thoroughly and well. He will be gifted with an immense humanity, so that he may dominate the technique and apply it with consummate skill.

An outgrowth of this will be some means of determining the true biological age of the individual, in a manner analogous to that used in establishing the intellectual age of the child. A mathematical formula must be developed which will express the anatomical, physiological, chemical, sensorial and psychological characteristics which define physical age.

Today we are living in an age of increasing mechanization. Human biology is at the centre of this mechanical whirl. Mechanism must serve man, not enslave him. The problem of working conditions, the problem of selection of personnel, suggest many other problems which will have to be dealt with.

Then the problem of health insurance—in its broadest sense—intrudes on our attention. Medicine knows not a therapy for the rich, and a therapy for the poor. A human being, thank God, is still a human being, in our democratic world.

To obtain a complete medical service for all the people—indigents, those of limited means, and those of average means—some form of health service must be made available so that the medical profession may keep pace with the ever-lengthening strides of medical research and development which is going on today in our modern world.

"The Scientific Attitude in Peace and War"

G. P. THOMSON, F.R.S.

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March 28th, 1942.

First of all, science derives from an interest in things and a belief that this interest is in some way worth while. Without this there can be no advance. Such a belief implies that there are things worth finding out in the particular field studied. The Greeks believed that discoveries were possible in the realm of pure thought and indeed made them. They hardly seem to have realized that there was much to learn about the facts of the world beyond what ordinary careful observation would tell them.

Men like Lucretius did indeed attempt explanations of the known facts, sometimes with uncanny insight, but they do not seem to have realised that the experiences of ordinary life were capable of any great extension.

Now I think that this failure to realise how much there was to learn came from living in a relatively static world, the world of the Medit-terranean.

It is a fair assumption that the real impulse to natural science sprang from geographical exploration. If this be so (and history bears it out) the true founding father of modern science is none other than Prince Henry the Navigator (1394-1460), the Portuguese prince whose seamen, fighting the superstitious beliefs of their day, pushed down the west coast of Africa, and, after his death but under his influence, rounded the Cape of Good Hope and reached their goal of India.

Then, through the work of Galileo, Bacon, Gilbert, and other men of their stamp, the scientific method was formulated and applied.

One must admit that a good deal of tosh is spoken about the scientific method, for basically, it is a method that anyone of normal intelligence would be expected to use, provided his mind had not been perverted by the metaphysical or mythological monstrosities of the ancients.

Consider the ordinary garage mechanic of today. He, if he is capable, practises the scientific method almost to perfection. First he gathers experimental data. He reviews his experiences with motor cars of similar make and subject to a similar problem. He then formulates a theory on the basis of his experience and his observations. Then he attempts to check the theory by making experiments—i.e., altering the mixture, setting the magneto, and so on, or perhaps by simply changing a suspected part for one known to be good. Now, that is essentially the

scientific method, and the most experienced research worker in a university laboratory could not teach a good mechanic much on that side of his work.

As time went on, it was established that the experiences of ordinary life cover a wealth of hidden facts and principles. Thus natural science—as distinct from philosophy—came into being, and men began to realize the truth of what is at once the queerest and the most important principle of science—the importance of the trivial.

It appears at first sight that trivial phenomena can teach us little about the structure of the great masses of matter which surround us. Yet it was, for example, from the behaviour of little bits of straw pulled about by amber, that men drew their first theories of electricity. It is from the out-of-the-way, the unusual, the queer, the bizarre, that man draws the deep and eternal principles which govern the universe. To understand the sublime, the human mind must first consider the ridiculous. Failure to comprehend that fact has robbed philosophy of its opportunity to reach results of lasting importance.

If I had to venture an explanation, I would suggest that one reason may be that trivialities do not have emotional content and that emotion is the greatest enemy of good judgment Certainly men of science have always tried to avoid emotion in their work—not always successfully when it comes to controversy with a rival. Their relative success is one of the chief causes of the rather frightening (to a scientist) esteem in which we are held in many places. Scientists are trusted because they are thought unbiassed. Truth and truth alone should be, and often is, their only criterion of merit, their only "value." Science, as science, predicts the consequences of an act; it does not judge whether they be good or bad. It is terribly important for scientists to keep rigidly to this view. If we abandon it we shall rightly lose all influence, and shall be lucky if we escape the fate of the Pythagoreans slaughtered by an infuriated populace for an early attempt at technocracy.

Science in war has much in common with engineering. If one defines engineering as the application of scientific knowledge to the service of man, the efforts of the war scientist may properly be termed engineering. Perhaps the primary difference between science and engineering is that the scientist is all the time searching for new effects and causes, and attempting their precise measurement, while the engineer is looking for some means to use these effects for a useful purpose, or what he considers a useful purpose.

Again, the scientist need only think. The engineer must think and act—though every experimenter has a little of the engineer in him.

The scientist in battle-dress must largely adopt the engineer's point of view. In particular, he must accept the necessity for compromise between conflicting requirements, which is almost the life blood of engineering.

Then, too, war intensifies the importance of speed, and forces an acceptance of the "good enough" which many men of science find distasteful.

"The better is the enemy of the good." When a man sees a development which would obviously improve the efficiency of his product by quite an appreciable amount, it is difficult to persuade him to stop work and turn what he has got over to service trials and ultimately production. Yet only by being ruthless in this way can new developments be got into action soon enough to be effective.

The scientist must strive for simplicity of operation so that in the heat of action, under conditions of human stress, the least possible demands will be made on the limited amount of nervous energy the operator has at his disposal.

All this involves a considerable change in attitude, but a rather surprisingly large number, especially of the younger men, have been able to make it, and their work has exercised an influence on the war, whose importance cannot be fully set forth as yet.

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CAPTAIN (AFTERWARDS GENERAL SIR J. HENRY) LEFROY, R.A., F.R.S., ETC.	1852-53
HON. CHIEF JUSTICE (AFTERWARDS SIR J. BEVERLEY) ROBINSON	1853-54, 1854-55
G. W. (AFTERWARDS HON. G. W.) ALLAN	1855-56
HON. CHIEF JUSTICE DRAPER, C.B.	1856-57, 1857-58
HON. G. W. ALLAN	1858-59
PROF. (AFTERWARDS SIR) DANIEL WILSON, LL.D., F.R.S.E.	1859-60, 1860-61
HON. J. H. (AFTERWARDS CHIEF JUSTICE SIR JOHN) HAGARTY	1861-62
REV. J. McCAUL, LL.D.	1862-63, 1863-64
HON. (AFTERWARDS SIR) OLIVER MOWAT	1864-65, 1865-66
PROF. HENRY CROFT, D.C.L.	1866-67, 1867-68
REV. PROF. WILLIAM HINCKS, F.L.S.	1868-69, 1869-70
REV. HENRY SCADDING, D.D.	1870-71, 1871-72, 1872-73, 1873-74, 1874-75, 1875-76
PROF. JAMES LOUDON, M.A., F.R.S.C.	1876-77, 1877-78
PROF. (AFTERWARDS SIR) DANIEL WILSON, LL.D., F.R.S.E.	1878-79, 1879-80, 1880-81
JOHN LANGTON, M.A.	1881-82
J. M. BUCHAN, M.A.	1882-83, 1883-84
PROF. W. H. ELLIS, M.A., M.B.	1884-85, 1885-86
W. H. VANDER SMISSEN, M.A.	1886-87, 1887-88
CHARLES CARPMAEL, M.A., F.R.S.C.	1888-89, 1889-90, 1890-91
ARTHUR HARVEY, F.R.S.C.	1891-92, 1892-93
R. RAMSAY WRIGHT, M.A., LL.D., F.R.S.C.	1893-94, 1894-95
A. B. MACALLUM, M.A., PH.D., LL.D., F.R.S.	1895-96, 1896-97, 1897-98
B. E. WALKER, D.C.L., F.G.S. (AFTERWARDS SIR EDMUND)	1898-99, 1899-1900
JAMES BAIN, D.C.L.	1900-01, 1901-02
A. P. COLEMAN, PH.D., F.R.S.	1902-03, 1903-04
GEORGE KENNEDY, M.A., LL.D., K.C.	1904-05, 1905-06
R. F. STUPART (AFTERWARDS SIR FREDERIC)	1906-07, 1907-08
J. J. MACKENZIE, B.A., M.D.	1908-09, 1909-10
J. B. TYRRELL, M.A., F.R.S.C.	1910-11, 1911-12, 1912-13
F. ARNOLDI, K.C.	1913-14, 1914-15, 1915-16
J. C. McLENNAN (AFTERWARDS SIR JOHN), PH.D., F.R.S.	1916-17
J. MURRAY CLARK, LL.B., K.C.	1917-18, 1918-19
PROF. J. C. FIELDS, PH.D., F.R.S.	1919-20, 1920-21, 1921-22, 1922-23, 1923-24, 1924-25
PROF. J. J. R. MACLEOD, D.Sc., LL.D., F.R.S.	1925-26
ARTHUR HEWITT	1926-27, 1927-28
PROF. W. A. PARKS, PH.D., F.R.S.	1928-29
PROF. R. B. THOMSON, B.A., F.R.S.C.	1929-30
T. A. RUSSELL, B.A., LL.D.	1930-31
E. F. BURTON, B.A., TOR., CAMB., PH.D., F.R.S.C.	1931-32
JOHN PATTERSON, M.A., F.R.S.C.	1932-33
SIR ROBERT A. FALCONER, K.C.M.G., D.LITT., LL.D., D.C.L., OX., F.R.S.C.	1933-34, 1934-35
J. ELLIS THOMSON, B.A.Sc., PH.D., F.R.S.C.	1935-36, 1936-37, 1937-38
ARTHUR R. CLUTE, K.C.	1938-39
PROF. J. R. DYMOND, M.A., F.R.S.C.	1939-40
WILLS MACLACHLAN, B.A.Sc.	1940-41
PROF. L. JOSLYN ROGERS, B.A.Sc., M.A.	1941-42
PROF. T. F. McILWRAITH, M.A., (Cantab.), F.R.S.C.	1942-43
OTTO HOLDEN, B.A.Sc., C.E.	1943-

Historical Note.

ON June 20th, 1849, a small gathering of surveyors, architects, and civil engineers, practising in and around Toronto, met in the office of Mr. Kivas Tully, to form an association of members of the three professions throughout the province. Out of this grew the Canadian Institute.

The original members of the Institute were William E. (later Sir William) Logan, John O. Brown, Frederick F. Passmore, Kivas Tully, William Thomas Ridout, and Sandford (later Sir Sandford) Fleming. Of these, Sir Sandford Fleming, the originator and founder of the Institute, was the last survivor. He died on July 22nd, 1915, 66 years after its foundation. The association was incorporated by Royal Charter granted on the 4th of November, 1851, and became known as the "Canadian Institute."

Sir William Logan, who was the first president of the Canadian Institute, was succeeded in 1852 by Captain (afterwards General Sir J. Henry) Lefroy, R.A., F.R.S., Director of the Imperial Magnetic Service in Toronto and later Governor of Tasmania and of Bermuda.

Beginning with the year 1851, there was published by the Institute "The Canadian Journal: A repertory of Industry, Science and Art," under the editorship of Henry Youle Hind, who had conducted explorations in Western Canada, and was then Professor of Chemistry in Trinity University. In a later series the Rev. Henry Scadding, D.D., who was president of the Institute from 1870 to 1876, published his well-known series of "Collections and Recollections on Toronto."

Weekly meetings of the Institute have been held consecutively each year from November to April since the Royal Charter was granted in 1851. At the earlier meetings, papers on scientific problems of the day were read and discussed, and practical work was carried on by the various sections which were under the administration of the Institute. The most outstanding of these were the Biological Section, the Geological and Mining Section, and the Historical Section.

About the beginning of this century it was felt that the discussion of scientific papers did not convey to the public the benefit of the knowledge involved in them, nor the important results that had been attained. In order, therefore, to establish a more direct communication with the public, the system of weekly Saturday evening lectures was begun, with the object of directing the attention of the people to questions of public interest and utility on which scientific opinion might have an important bearing.

A few of the accomplishments of the Institute are to be found on the following pages, and from them it may be seen that the objects of the charter, granted in 1849, have been pursued steadily ever since.

On the 2nd of April, 1914, His Majesty the King granted permission to change the name to "Royal Canadian Institute."

Some of the Outstanding Accomplishments of the Royal Canadian Institute

1. Co-operation in promoting the meetings in Toronto of the following scientific societies:

(a) The American Association for the Advancement of Science, 1889 and 1921.

(b) The British Association for the Advancement of Science, 1897 and 1924.

(c) The International Geological Congress, 1913.

(d) The International Mathematical Congress, 1924.

2. Standard Time.

In 1878 Sir Sandford Fleming brought forward the plan of adopting for the whole earth, twenty-four standard meridians, fifteen degrees apart in longtitude. He published many papers on this subject, and with the co-operation of the Institute, the zone system of time-reckoning was adopted in most of the countries of the world.

3. The Museum.

The Ontario Archaeological Museum was begun under the auspices of the Institute, and continued under its management for six years before being transferred to the Ontario Government and the University of Toronto.

4. Publications.

The Publications of the Institute have appeared in four principal series and one minor series as follows:—

(1) "The Canadian Journal: a Repertory of Industry, Science and Art," and a Record of the Proceedings of the Canadian Institute. 3 vols., 4to. Begun August, 1852, ended December, 1855.

(2) "The Canadian Journal of Science, Literature and History." 15 vols., 8vo. Begun January, 1856, ended January, 1878.

(3) "Proceedings of the Canadian Institute." 7 vols. Begun 1879, ended April, 1890.

(4) The Archaeological Reports of the Canadian Institute were published as part of the Appendix to the Report of the Minister of Education for the Province of Ontario, 1886-1894.

(5) Minor Series. "Proceedings of the Canadian Institute." From 1897 to 1904, two volumes of this series, containing short papers, were published.

(6) "Transactions of the Royal Canadian Institute." Begun October, 1890, and up to October, 1942, Part 1 of the twenty-fourth volume has been published. This publication contains scientific papers on technical subjects, relating to all branches of science. These papers are submitted by those doing research work. The publication is sent to learned societies throughout the world, and these societies send their own publications in exchange. Any Ordinary member of the Royal Canadian Institute may receive a copy of this publication upon request.

(7) "Proceedings of the Royal Canadian Institute." Series IIIA. Abstracts of the lectures given during the year. Begun 1936 and to date eight volumes have been published.

(8) General Index to Publications, 1852-1912. Compiled and edited by Mr. John Patterson. Dr. J. B. Tyrrell, President of the Institute, 1910-1913, undertook to finance the compilation of the index, and made it possible for the Council to proceed with the work.

5. The Library.

As a result of the exchange of publications with learned societies for the past ninety-four years, the Institute has built up a most important scientific library of over thirty thousand volumes, many of which are indispensable to scientific workers in this part of Canada. For protection against fire, this library is housed in a section of the library of the University of Toronto, and may be used by the staff and students of the University as well as by members of the Institute.

6. The National Research Council and the Ontario Research Foundation.

It was in large part due to the vigorous campaign of the Institute on behalf of a wider application of science to industry in Canada, that the Honorary Advisory Council for Scientific and Industrial Research, the forerunner of the National Research Council, was appointed by the Dominion Government, and that the Ontario Research Foundation was instituted through the co-operation of the Ontario Provincial Government and manufacturers.

7. University Grant.

The Institute also strongly supported the successful application to the Provincial Legislature for an annual grant for research in the University of Toronto.

Report of the President

1942-1943

As presented to the 94th Annual Meeting, Saturday, April 3rd, 1943, held in the Royal Ontario Museum.

During this last year our thoughts have inevitably been centred on world affairs, on the struggles in Russia, in the North Atlantic, the Pacific, and in North Africa. This report, therefore, is the report of an institution within a nation at war.

What place does the Royal Canadian Institute occupy in time of war? My own belief, and this has been shared by members of your Council, is that the Institute has a very important role to perform. The welfare of our country depends upon the intelligent co-operation and support of us all —we are not mere pawns in a totalitarian state—we are the state itself. It is true that a considerable number of our peacetime rights must properly be handed over to executive branches of the government, but in the last analysis the government rests upon, and is controlled by, the citizens of Canada. This is a tremendous responsibility. It means that a good government can only be maintained by an intelligent population. Even more in war than in peace, I consider that it is the responsibility of the individual to maintain an intelligent appreciation of modern developments; it is the privilege of educational institutions to foster the dissemination of information for the benefit of the individual, and accordingly, for the benefit of the state of which he is a part.

If this point of view be correct, then upon such societies as ours rests a full responsibility for carrying on. This we have tried to do during the last year, facing the inevitable difficulties of the period.

I am sure that you all recognize the three main functions of the Institute—the spreading of knowledge by means of our scientific publications—the building up of our library for the benefit of research workers— and the holding of public lectures whereby the latest developments in science are made known to the citizens of Toronto. These three aspects of the Institute's work have all been maintained.

With regard to our publications, our Honorary Editor, Professor E. M. Walker, has been responsible for bringing out a volume of Transactions as well as one of Proceedings. Those who know Dr. Walker need no assurance that the high scientific standing of our publications has been maintained. The Institute has been grateful to Dr. Walker for his work over many years.

In the library the impact of the war has been very severely felt. Obviously, publications from enemy sources have been unavailable for several years, and the difficulties of ocean transit have interrupted mail service between Canada and the neutral countries, as well as between ourselves and the other Allied Nations. Consequently, the number of publications received has been less than usual, and there are gaps in the numbers received which will prove difficult to fill. Our Honorary Librarian, Professor Craigie, has made every effort to reduce the count of these missing numbers but he is facing an extremely difficult situation from which there seems no easy road of escape. Moreover, within our own organization, the library has suffered. As you know, our former Executive Secretary, Mr. Murray, was given leave of absence a year ago. His work has been taken over by Mrs. C. S. Rawlings who formerly carried out many of the actual details in the library. Since her time for this work has thus been curtailed the library has suffered. It is difficult to obtain a part-time library assistant, still more difficult to find the time to instruct and supervise such a part-time worker, and consequently there has been a decline and not advance in the efficiency of the library. I regret that this is the case but I think the facts are clear.

Our third main function, that of the holding of public lectures, has been maintained. Our programme has comprised twenty lectures, delivered in Convocation Hall on Saturday nights. I think your Lecture Committee has to be congratulated on the type of programme arranged by them. Each speaker has been qualified to deliver an address on some aspect of modern science. The programme has been perhaps rather heavier than in other years, a factor which has appealed to some of our members and not to others, but your Lecture Committee felt that this was a desirable point of view to stress in war. The lecturers have been drawn from our own university, from other Canadian universities, from Provincial scientific departments, from industrial enterprises in Canada and by scientists on the staff of the Dominion Government. From the United States we have had the usual co-operation which we have come to expect. From scientists in the employ of the American government, from the technical staff of industrial concerns, and from American universities we have had distinguished speakers. It is no light matter for a man to interrupt his work to prepare a semi-popular address and to take time to come to Toronto to deliver it. To all our guest speakers we are grateful. The Royal Canadian Institute has always been anxious to co-operate with other societies in the holding of joint meetings. We have met this year with the Toronto Branch of the Engineering Institute of Canada, with the Society of Chemical Industry, with the Toronto Chemical Association, with the Toronto Branch of the Archaeological Institute of America, and with the Toronto Section of the American Institute of Electrical Engineers. I think you will agree that these have been among our most interesting meetings. In a more informal way, we have arranged to have our out-of-town guests meet their local confrères at luncheon; that this has been

appreciated is shown by the fact that guests have come from London, Guelph, Hamilton and Ottawa. Perhaps it is presumptuous to speak of men from these cities as "local" confrères, but at least we in Toronto have shown ourselves willing to share our guests.

In connection with our lectures certain difficulties are encountered. First, I would name the acoustics in Convocation Hall. In spite of efforts made by a committee of your Council, and in spite of the fact that each speaker has been taken to the Hall in advance and coached in the use of the microphone, I realize that many of our members have had difficulty in hearing the speakers. To those who have been unfortunate in this way I tender my apologies; the difficulty would appear to be partly the fault of the speakers, and partly that of the hall; I would strongly urge that the incoming Council continue to try to solve the problem. Secondly, we have had the misfortune to meet appalling weather on various Saturday nights. Transportation problems have increased the difficulties due to the weather, and have contributed in no small measure to the diminution of our audiences. Finally, but by no means least of our problems, the longer hours and heavier responsibilities carried by so many individuals have limited their attendance. I feel that the success of a lecture can be measured not by the size of the audience alone, and though I regret that the number attending has been smaller this year than formerly, I think that those attending have received significant information on the branch of science in which they are interested.

A pleasing feature of our Saturday evening lectures, and one much appreciated by everyone, has been the organ music so beautifully rendered by Dr. T. A. Davies.

Financially, rigid economy everywhere and curtailment of expenses in library work has enabled us to carry through with a credit balance. Our Honorary Treasurer, Dr. Sigmund Samuel, has been able to present a very satisfactory statement which I will not give in detail, but which can be consulted by any member who would care to look into it at our headquarters at 198 College Street; parenthetically, may I ask that members do so, as the more interest shown by members in the Institute the better for us all. Briefly, and in round figures, our income has amounted to $9,000.00. This is derived from a provincial grant of $500.00 towards the support of the library, and the remainder, a trifle over $8,500.00 from membership fees and interest. Our actual expenditure has been $7,500.00; to this must be added approximately $1,000.00 necessarily set aside for the completion and binding of sets of periodicals which are unavailable during the war. We have, therefore, a small credit balance largely derived from savings in office assistance. I want to strike a note of caution for the future in pointing out that though expenses are properly curtailed in wartime, they must, sooner or later, be made up if the library is to be maintained accordingly to the long traditions of the Royal Canadian Institute.

We have welcomed 188 new members during this year, making a total membership of 1481. In an ideal world I am sure that individuals would struggle for the privilege of becoming members of the Royal Canadian Institute, but I sometimes feel that we have not yet reached that ideal state, and in cold fact the obtaining of members, both individuals and corporate, is a difficult and time-consuming task. I want to express particular appreciation to Mr. Publow, Chairman of the Membership Committee, and to Mr. George Gale who had done yeoman service for the Institute for many years, and who, having asked to be relieved of the responsibility of the chairmanship of the Membership Committee, turned in and laboured like a Trojan to help Mr. Publow. Against this gain of new members, the loss must be recorded of 182 members through death or resignation, and a further diminution, which we are proud to record, through the absence of members on active service.

We have been fortunate this year in our relations with the Press. In spite of the increased cost of production and increased demand for space, the newspapers have been generous in the advance notices and in their write-ups of lectures. We have held press conferences every Saturday morning throughout the year. I think the papers have welcomed the opportunity of interviewing distinguished scientists and our guests have been courteous in giving their time and information. This type of press conference was admittedly an experiment and I have made it my duty to be present every Saturday morning at these conferences and then to take the speaker up to Convocation Hall. Besides attending these morning conferences, the papers have been ably represented at the evening lectures. Mrs. Matthews, Chairman of our Publicity Committee, has done splendid work in her contacts with city editors. To her we are grateful.

For many years it has been the practice of the Royal Canadian Institute to show appreciation to our speakers by entertainment in Toronto. In spite of rationing and difficulties of transportation Mr. Eadie and the Entertainment Committee have arranged adequate hospitality and I think that all our guests have enjoyed their stay. We are indebted to a number of members of the Institute and their wives for the hospitality shown to our speakers. As an experiment, small receptions for members and their guests were held immediately after the lecture in the rotunda of Simcoe Hall. I think some members enjoyed these, but the location was not satisfactory, and I feel that the experiment can be considered only partly successful.

Both a War Services Committee and a Conservation Committee have been carried on during the year. Their work has been unostentatious and has consisted largely in help given, and co-operation with, existing organizations. It was the hope of the Institute that expansion might take place in the formation of branches in London and other cities; considerable correspondence has been carried on, and I made a trip to London, but the number of other obligations held by those likely to sponsor the organization

has made the present time inopportune. The matter is not dead but I am afraid that it will be after the war before we may look for much progress along these lines. Under the leadership of one of our Past Presidents, Mr. Wills Maclachlan, a committee has been set up to make preparations for the one hundredth anniversary of our founding. This will come in 1949, and if it is to be celebrated fittingly preliminary arrangements must be made well in advance. Another matter considered by your Council has been that of Honorary members. A report on this subject will be presented later this evening.

I referred to leave of absence last year of Mr. D. Bruce Murray, our Executive Secretary. Mr. Murray has since resigned and I wish to take this opportunity of thanking him for his services to the Institute, and to wish him on behalf of us all, the best of good fortune in his new position. Mrs. C. S. Rawlings has taken over the position of Executive Secretary and has done a splendid job. Hers is, at best, a difficult position, particularly in her first year and when her work was made more difficult by the rotation of officers. I wish to thank her on my own and on your behalf. We have had the good fortune to have had a very capable stenographer in Mrs. Watson who has lightened the work of Mrs. Rawlings and your Council considerably.

It is a pleasure to record the helpful co-operation I have had from my colleagues on the Council. Colonel Lamb, our First Vice-President, Mr. Eadie, our Second Vice-President, Professor Dunbar, our Honorary Secretary, and Mr. Publow of the Membership Committee have all spent many hours on work for the Institute. Indeed, Council generally has been most generous and helpful, so that the mentioning of these names may seem invidious. The difficulties of the year have been increased by the fact that two members of our Council are on active service, while others have been so engrossed in their activities that they have been unable to attend either Council meetings or Saturday evening lectures. This has thrown a still heavier burden on those left and I can only say that it would have been impossible to have directed the activities of the Institute without their consistent encouragement and help. As you know, we have a rotating system whereby three members of council drop off each year. This year we lose Professor Gilchrist, Mr. Mason and Professor Dymond. Professor Gilchrist and Mr. Mason have served four years as Councillors, and have contributed their full share to the Institute; and we regret the termination of their term of office. Professor J. R. Dymond, our Senior Past President, likewise ceases to be a member of Council since only three past presidents serve in that position. Professor Dymond became Honorary Secretary in 1931, served in that capacity until 1934, then became a member of Council and passed through the successive positions of second and first Vice-Presidents and President. He now leaves the Council after 12 years of continuous and conscientious service. Few have done more for the Institute, and I can speak with full knowledge when I say how helpful he has been during the past year. Professor Dymond is one of those distinguished

scientists who, some way or other, finds time to serve his fellows in his Museum activities, in his labours for the Royal Society of Canada, for the Royal Canadian Institute, for the Federation of Ontario Naturalists, for the Toronto Field Naturalists' Club, a public-spirited citizen whom we all honour and admire.

New blood will come with the new members of Council and I am sure that my successor will receive the same support and help that has been my good fortune. Personally, I have enjoyed my work with the Royal Canadian Institute, except perhaps the matter of picking up lecturers at 7 o'clock on a Sunday morning to get them to the train, and the writing of 310 letters in connection with our lectures. I submit this report with full appreciation of the honour you have paid me in giving me the responsibility of guiding its destiny during this past year.

The Saturday Evening Lectures

One of the objects of the Royal Canadian Institute is to further a popular interest in research. Since the results of research are so far-reaching in their effect upon the life of every member of the community, it is necessary to create an intelligent public who will be able to follow the work and achievements of those who are engaged in it.

What has been done in the past is illustrated by such important accomplishments as the invention of the telephone and the radio, the discovery of radium, the improvement of the telescope, also by the immense access of knowledge as to the structure of matter, whether in the atom or the universe, the manifold phases of life on the earth, and the exploration of the world.

The lectures of the Institute are the medium whereby such work is explained to the public. On Saturday evenings during the season, popular lectures of a scientific nature are given by men outstanding in their own field. The purpose is to interpret scientific research for the public.

"Race and Race Concepts"

T. F. McILWRAITH, M.A. (Cantab.), F.R.S.C.

Professor of Anthropology, University of Toronto, and Associate Director of the Royal Ontario Museum of Archaeology.

PRESIDENTIAL ADDRESS.

October 31st, 1942.

In a totalitarian state the primary function of a good citizen is to obey a dictator without question; in a democracy a citizen's obligation is to give the state the benefit of his intelligence and his knowledge. It follows that we in Canada have the responsibility of educating ourselves so that, in this time of crisis, we can play our part with efficiency. Accordingly, I have chosen for my presidential address the subject of Race, a theme of vital significance to-day, but one about which there has been a great deal of ignorance and loose thinking.

A study of race manifestly requires a study of mankind as a whole, and this entails the problem of classification. From early times we find that peoples have attempted to classify themselves and their fellows; moreover, some of the difficulties apparent in the dawn of history are still with us to-day. Among these I would mention first the difficulty of *objectivity*. It is easier to study the stars, plants, or minerals in a detached manner than it is to deal with our fellow men. Yet mankind must be regarded in a thoroughly objective manner if our conclusions are not to be vitiated by personal bias.

A second difficulty in the classification of mankind has been *ignorance*. The ancient Egyptians, unhampered by too much knowledge, classified mankind in a very rough and ready manner, using colour as their principal criterion; they considered themselves as red-brown, the Asiatics as yellow, the Negroes as black, and the westerners or northeners as white. The classifications of later generations were more disturbed by legends and myths, whereby strange semi-human creatures were included in their findings. One of the earliest and most naive of these descriptive classifications is taken from Strabo, a geographer who lived about the time of Christ and who included the following creatures:

> "Such are the Amukteres, that want Noses, and have only two holes above their Mouth; they eat all things, but they must be raw; they are short lived; the upper part of their Mouths is very prominent. The Enotokeitai, whose Ears reach down to their Heels, on which they lye and sleep. The Astomoi, that have no Mouths—a civil sort of People, that dwell about the Head of the Ganges; and live upon smelling to boil'd Meats and the Odours of Fruits and Flowers; they can bear no ill scent, and therefore can't live in a Camp. The Monommatoi that have but one Eye, and that in the middle of their Foreheads: they have Dogs' Ears; their Hair stands on end, but smooth on the Breasts. The Sternophthalmoi,

that have Eyes in their Breasts. The Panai sphenokephaloi with Heads like Wedges. The Makrokephaloi, with great Heads. The Huperboreoi, who live a Thousand years. The Okupodes so swift that they will out-run a Horse. The Opisthodaktuloi that go with their Heels forward, and their Toes backwards. The Makroskeleis, the Staganopodes, the Monoskeleis, who have one Leg, but will jump a great way, and are call'd Sciapodes, because when they lye on their Backs, with this Leg they can keep the Sun from their Bodies." [1]

Such bizarre concepts were held as late as the seventeenth century. The following is taken from a map of the Kingdom of the Saguenay on the north shore of the St. Lawrence, published in that century.

"Herewith is the demonstration of a race called pygmeous, small people of about a rod high. At the age of three they breed and at eight they die without having known shyness or justice or honesty, and for their turpitude they are considered brutes rather than men. It is said that they are incessantly at war against birds called grues—'cranes'." [2]

We may smile at the credulity of Strabo or of the seventeenth century cartographer, but we must remember that throughout the Middle Ages tales of giants, dwarfs, amazons and mermaids were accepted without question. Indeed we are barely beyond that period to-day, and many of us can remember as children the alluring invitations to pay our money to see the tailed man from Africa, the wild man of Borneo or some other allegedly semi-human creature. And in parts of South America it was only yesterday that it was necessary to point out that the aboriginal Indians did not have tails, did not and could not leap through the branches like monkeys and were, in fact, human beings.

Not only has ignorance confused the classification of mankind; a third difficulty, *prejudice* has also played a still larger part in obscuring the truth. If we go back to the days of Rome, we find, in fact, that the only classification of man which was significant was whether or not an individual was a Roman citizen. Our ancestors in the British Isles, for example, were *barbari*, and although the remark attributed to Gregory (was it not?) that the blue-eyed slaves were not Angles but Angels may be apocryphal, none the less it indicates the tenor of the times when those who were not Roman citizens were outside the realm, irrespective of their physical characteristics. So too in China in the 18th century, when the inhabitants of the Middle Kingdom looked askance at all foreigners. So too, in Scotland in the 17th century, when the Macdonalds and the McLeods were warring in the Outer Isles and those who did not belong to the clan which had predominance at the moment were regarded as barely human. So was it in England, when in the 18th and 19th centuries slavery was a respectable practice and negroes were rounded up like wild beasts and sold on the block with no feeling that they were human beings at all. The history of the Inquisition abounds in cruelty when Roman Catholic burnt

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1. This summary of Strabo is taken from Haddon, A. C., History of Anthropology, London, Watts & Co., 1920, p. 26.

2. Barbeau, C.M., The Kingdom of the Saguenay, Macmillan Co., 1936, p. 15.

Protestant and Protestant burnt Roman Catholic, and both regarded Jews as inferior creatures. Here the criterion of classification of mankind was based not at all upon the biological characteristics, but upon religion. Hitler to-day has turned back the hand of time and has given to the world the spectacle of human beings classified in accord with their membership or non-membership in the Reich. Inquisitors of the 17th century showed an equal mentality, but never his deliberate ruthlessness. Classifications of mankind have over and over again been swayed by tribal, by national or by religious sentiment, in which physical or racial characteristics have played an insignificant part.

What of the present? With our modern knowledge, we may place the monsters of Strabo or of the Middle Ages in the limbo of mythology, and we can disregard completely the biased imaginings of Hitler, but are we ourselves governed by the scientific facts regarding mankind so that our attitudes are in accordance with these facts?

Modern knowledge reinforced by photography has made us perfectly familiar with the physical appearance of peoples in all parts of the world. The black-skinned Negro of Africa, the wavy-haired Australian aborigine, the straight-haired American Indian, the Philippine Islander, the Samoan, or the Papuan of New Guinea, are all familiar figures. They may strike us as somewhat unusual physical types, but they do not appear as strange creatures from another world as they would have to our fathers and still more to our grandfathers; but, like every other group in the world, we tend to think of ourselves as normal and of other people to a greater or lesser degree, queer. We are white people and imply that that term is definite and uniform, whereas, in cold fact, we are a very mixed group. One has only to look at any audience to see the force of this statement. Take stature for example. The normal distribution of height varies from 5′ 4″ to 6′ 2″. A difference of 10 units in 64 units is a difference of some 15% mathematically. In our society such a difference is completely inconsequential, and therefore unnoticed, but no mathematician would accept the thesis that two objects that differ by 15% are the same. Equal diversity is apparent in eye colour, where the common range is from very light blue to black. Here too, there is nothing approaching biological uniformity. In hair we are familiar with shades that pass from tow, to gold, to brown, to black, with a series of reds as well. So for other characteristics, complexion, shape of the nose, face and head, hairiness, texture of the hair, size of the mouth and many others. Until these differences are pointed out we do not notice them at all, because they are all familiar in our own society.

In brief then, we are not biologically homogeneous, but we do not notice the differences which are familiar. Our population consists of a number of overlapping types, ranging from fair-haired blondes to swarthy brunettes.

If, in one's mind's eye, one should go to the Eastern Mediterranean one would be in an area where the most common type was definitely darker

than our own, and with curlier, darker hair. Again there would be no absolute uniformity, but the range would be on a much darker scale than that with which we are familiar. Go further south to the borders of Negro Africa and there would be a similar range of variation, but on a still darker plane with a Negro not appearing radically different from the norm; and finally, in central Africa the dark-skinned Negro is the common type. Hence we may say that there are intermediate forms which show every degree of intergradation from the fairest of North Europeans to the blackest of Negroes. The differences in various varieties of mankind are obvious and we tend to think of them.

A different picture appears, however, when we think of human resemblances.

1. The framework of every variety of man is identical, bone for bone, muscle for muscle, nerve for nerve. This extremely complex organism, the human body, is the same throughout the world.

2. The muscular movements of man are identical. Take for instance, the extremely complex movement of rotating the hand at the wrist and flexing the five digits. Such a movement is almost beyond the ability of a machine yet it is a commonplace ability of every variety of mankind.

3. The same biochemical processes are involved whenever man assimilates food and transforms it into bone or skin or cartilage or muscle.

4. Such intricate organs as the heart, the lungs, the liver are identical.

Surely any mechanic examining two trucks having comparable complex identities in internal structure and engines would say that the two vehicles were essentially the same, even if one were painted black and the other white, even if the headlights were blue or black, and irrespective of whether one were 15% longer than the other.

Two other points should be mentioned briefly. Man is fundamentally so similar that he is subject to the same diseases, and, moreover, the most diverse types can interbreed.

For these reasons it is justifiable to speak of the essential unity of mankind, though this does not mean that mankind is uniform. Groups in various parts of the world differ in physical characteristics, indeed no two individuals are identical, but the traits common to all human beings are sufficient to warrant their description as a single species, *Homo sapiens*. The intergrading specialized types of man may be described as sub-species. Anthropologists tend to use the term *race* for *Homo sapiens* as a whole, *sub-race* for the *sub-species*.

In view of the way in which diverse types intergrade one can readily see how difficult it is to classify the subdivisions of mankind. Everyone knows, for example, the Negro type with broad nose, black skin, curly hair and everted lips; so likewise, the Nordic with fair hair, blue eyes, pink

and white complexion, tall stature, long neck, big bones, huge hands and enormous feet. These two types are easily recognizable, but, taking the Nordic as an example, one can see the endless difficulty of trying to classify individuals with, for example, fair hair, but dark eyes and small build, or those having the stature and build of a Nordic but the complexion of a southern European. Truly, man is a mixed creature and any attempt at a rigid classification of sub-species within the whole is impossible. Thus it is nothing but an absurdity to imagine that any nation, England, France, Belgium, or any example you choose, is biologically "pure" or uniform. In fact only Germany makes any claim along these lines, and no scientist would pay Hitler the compliment of believing his claims. Nationality and physical characteristics do not coincide. Think for instance of the Scots; among whom are to be found the small-boned dark Highlander, the big, dark, hairy individual from the Outer Isles, the red-haired and freckled-faced Camerons, and the big blond Nordics. All are Scots. But even if one were to conceive an impossible situation, namely, that a specific type could ever coincide with a nation, there would still be no basis for assuming national superiority, because no type is superior to another. In our mixed society we recognize individual mental variations; but success in our community, measured by any criterion you choose, is never correlated with physical type. None but Hitler would claim that all Nordics take first class honours in university examinations. The Nordic with his powerful build has a great advantage in a hand-to-hand combat, but success in rough-and-tumble fighting is no longer a serious consideration in modern life. One has only to think of the great figures of history to realize that they were not all Nordics, or indeed of any one type.

This leads to the question whether there are appreciable mental differences among the various sub-types or sub-races of mankind. Remembering the biological unity, one would expect similar mental unity, even though this runs counter to the general assumption that "we" are superior to all other peoples. Remember that others have the same ideas. Not long ago an Indian friend of mine commented to me on the stupidity of the white man. "If we knew of a bad man who was collecting guns and ammunition, we would kill him. You white men knew what Hitler was doing but you were too stupid to stop him before he was well armed." I know that my Indian friend was not convinced of the white man's intelligence. Or I remember hearing in 1931 of the western business man who spoke patronizingly to a Chinese merchant of the latter's archaic methods. "Maybe", said the Chinese, "but we did not have the collapse of our stock-markets in 1928". An Eskimo would be horrified, nay shocked, at our unequal distribution of food and clothing, sharing being a vital part of his culture. Man, including ourselves, is apt to forget the biblical parable of the motes and beams in regarding all other peoples as inferior.

What basis is there for an assumption of mental superiority and inferiority, and how can it be judged? How can we compare the ability of an Eskimo to perform the exacting tasks of his life, together with the minute requirements of his social and religious beliefs, with the abilities

required to be a successful citizen of Toronto? If one of us were to be dropped suddenly into an Eskimo household we should be woefully uncomfortable, and indeed should probably be unable to survive. But remember that an Eskimo would unquestionably regard attendance at a lecture as an experience as agonizing to him as participation in a blubber feast would be to us. Our society is highly specialized in regard to mechanics, and mechanical developments have made possible complex methods of world transport and world intercommunication so that the discoveries of science in any part of the world are made available rapidly to all other regions. Therefore, the works which we judge as our own are, in fact, the products of the labour of many individuals in many parts of the world through many generations. The motor car, the electric light, the radio and other essentials of "our" civilization are due to workers completely unknown to us. We profit from them, but most of us would be incapable of producing electric light, glass, radio equipment, or steel if forced to depend upon our own knowledge, and forced to depend, moreover, upon tools made with the materials immediately at hand. Judged from this standard the mechanical achievements of various parts of the world become definitely comparable to our own massive bridges and skyscrapers. Who, for example, among ourselves could stretch a bridge across a river with only pendant vines and bamboo as the only bridge-building material? And yet the Pygmies of the Congo do this. Which of us can produce as symmetrical a pot or one as accurately decorated as a thousand potters among the Indians of the South-West? A specialist among us could, but to the Pueblo Indians of the last century virtually every woman had this degree of professional skill. Or think of the labour and skill involved in clearing large patches of forest in Southern Ontario with stone axes as was done by the Iroquois people who were here at the time of the French incursion. So too, in the realm of purely abstract intellectual matters. How can one evaluate the Mexican discovery of the mathematical concept of nothingness; the Aztec dedication of a temple to the Cause of Causes conceived as a non-anthropomorphic deity; or the Polynesian concept of the development of the world through 19 eras each stretching from a thousand years upward to infinity? We are apt to think that we alone have developed a mode of life with complicated social economic and religious factors, but we are not alone in the development of fantastic institutions. It is so difficult for anyone to judge the complications of anyone else's mode of life that it is impossible to compare or appraise accurately.

Even aptitude or intelligence tests are of only slight value in this case. We might think that mechanical tests which emphasize the processes of fitting together squares, circles or other blocks call for no previous experience and, therefore, would be equally fair to individuals in every part of the world. But from infancy we have been accustomed to squares, rectangles and other precise geometric patterns, familiar with them from the time we lay on our backs and looked at the right-angled corners of the ceiling or the cylindrical bars of our cribs. The knowledge absorbed by an infant in this way gives him an advantage in any task

which includes the use of bricks or blocks, in contrast to the child of the Australian native whose experience has been with irregularly shaped branches with oval and inexact roofs, and who has never handled anything in his life that was either circular or rectangular. Tests of native child and white child prove conclusively that the white child is more proficient in terms of white culture, but that one would expect. With such tests one can indicate the degree of difference between different groups in respect to European culture, but they show nothing whatever in regard to the relative intelligence of white and non-white. Remembering the biological uniformity in all other respects we are justified in believing that man is essentially of the same mental ability; individuals vary in different groups, but mankind is basically the same.

Let me give one illustration of complicated mental activities in two areas of the world. One of the most complicated mental activities in our own society is the so-called "game" of chess which originated, by the way, in Asia. Each player controls 16 counters which can be moved only in a certain limited number of ways. The movements are precise; there is never a trace of hurry in any of the movements and the furrowed brows of the players show that a truly enormous amount of brain power is expended in defeating the wiles of one's adversary who is moving a similar set of pieces round the board. Compare with this the mental ingenuity required in the manufacture of figures from string among primitive peoples, a widespread game in which the participants usually, and the spectators always, seem to derive much more pleasure than from a game of chess. In a single figure, instead of the marked squares of a chess board, the player uses his 10 digits supplemented upon occasion by the toes, mouth, neck and wrist. Moreover, on each of these ten digits not one, but as many as four loops may be placed. Each may be placed in either of two directions. The order of placing is significant and precise. A single error will ruin a completed figure, a single error from a smaller range of possibilities is not irrevocably fatal in chess. In a completed figure the accuracy, detail and range of movement are all on a scale of elaboration equalled by very few mental activities among ourselves. How such figures were ever worked out in the first place is difficult to understand. It may be said, and rightly, that this is a mere game—so is chess; each is an illustration of complicated mental processes, one taken from our own society, one from a primitive area.

It is difficult to realize the attainments of those who have reached eminence in other communities, but men of genius are not limited to our own. We must not forget that Plato and Aristotle and even Shakespeare flourished in societies which would be regarded to-day as simple and, indeed, primitive. Our grandparents would seem ignorant and backward could they return to our modern life, but not one of us would claim to be more intelligent than his grandfather, despite the latter's ignorance of modern mechanical developments. There is no proof of the mental superiority of any group of mankind.

If, then, man is essentially one, in physical and mental characteristics

alike; and if, moreover, every nation contains a mixed population, what is the basis for the feeling of race attitudes, or race prejudices, which are apparent to-day as at any other period of human history? And apparent both in respect to foreign groups and, distressingly enough, within our Canadian population. The answer is not in biological traits, but in culture.

Consider some of the examples already given; of the Roman classification based upon citizenship; of the Mediaeval dependent upon religion, with the accompaniment of the Inquisition; of the blood-thirsty clan fueds of the Scottish Highlands, and of a thousand comparable illustrations. These differences were not based upon physical characteristics, but upon much more vital factors, the attitudes of the groups concerned towards the idiosyncrasies of the members of other bodies. The things that really matter are our religious beliefs, our social structure, our education, our economic fabric, the sum-total of our way of life, or, to use the anthropological term, our culture. That of no two groups is identical, and every group prefers its own.

Preference for one's own culture does not warrant an assumption of superiority with regard to that of everyone else; still less does it justify contempt for those who follow other modes of life. Some of my best friends are North-West Coast Indians. Though I regard a number of them with sincere affection, I would not wish to follow their customs, nor would they wish to change places with me. I admire wholeheartedly and pay unqualified tribute to Russia, but I prefer the Canadian way of life to the Russian. I do not know which is superior, which is inferior, but I, like everyone else, prefer my own. This has nothing to do with the physical characteristics of the Canadians or Russians; it is a question of culture. I detest wholeheartedly everything for which Nazi Germany stands, but my hatred of the Germans is not based on racial grounds, it is based on cultural. The descendants of Germans who fled or left Germany in the last century and who have been born and brought up in Canada are biologically of the same stock as the Germans of Europe, but culturally they are an integral part of the Canadian population. Our likes and dislikes, whether personal or national, are based upon culture, not upon physical characteristics; the assumption that a certain trait which we admire or scorn is hereditarily linked with a biological type is entirely false.

Finally, may I point out that cultural classifications change. The feuds of the Scottish Highlands and the religious schisms of the Middle Ages have, happily, passed away, but we are apt to view intolerently the activities of cultural groups within our own community, forgetting that those traits which we notice adversely are capable of modification. Our society is as mixed culturally as it is biologically. We have our own religions, our own literary tastes, our own hobbies, our own minor personal tastes. Let us realize that the variations within our own culture are the result of cultural growth; it is the part of wisdom to view them with tolerance.

The thesis advanced in this paper may be summed up very briefly. All man is of the same species, *Homo Sapiens*, a biological and mental unity, having many intergrading sub-species. Feeling of tension between groups is based not upon biological grounds, but upon cultural differences which are due to education and to the chances of history. If we grasp these facts our relations to our fellow-men will not rest upon the too-easily generated sentiments of adulation on the one hand, or of prejudice on the other, but upon conclusions reached through an intelligent appraisal of the facts of culture. If we hate, we hate with reason; if we admire, we admire with reason; if we dislike, we can analyze the reasons for our dislikes and can show tolerance. Let our behaviour be based upon science, not upon prejudice; we cannot plead ignorance to-day, as could our forefathers of the Elizabethan Age.

"Soil Conservation Goes to War"

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November 7th, 1942.

At the time of the first World War, we were not much concerned with soil conservation because we had been thinking all along that our resources of productive land were limitless and inexhaustible, that we were the best farmers in the world, and that everything was going splendidly with the land. We did not know the enormity of the soil erosion problem, were not concerned about it, and had no national programme for conservation and protection of the land.

What was the cost of that ignorance, indifference, and inaction? It may be summed up as follows:

1. A plowup of some 30 million acres of new cropland during the period of the first World War, a large part of which was land that never should have been touched with the plow.

2. The development of a new terrestrial phenomenon in America—new to America, but old to the regions of the Sahara and Gobi deserts—the phenomenon of great dust storms; the first of which originated in the plains at the base of the Rockies and literally blotted out the sun over Washington, D.C., on May 12, 1934, sweeping an estimated 300 million tons of soil material out of the fields of the Plains farmers and giving a lot of New Yorkers their first real taste of Great Plains wheat soil.

3. The development of an unnecessary, unwanted, man-induced land problem that has been costing the United States around $3,844,000,000 a year in damage to crops and grazing lands; in removal of potential supplies of fertile soil and soil-building material; in the waste of fertilizer and

seed—along with a host of other costly damages, such as damage to railroads, to highways, and even to city streets; damage by intensified floods; damage to fish and oyster resources; and the filling of stream channels, reservoirs, harbours, ditches, and even the cellars of homes, with water-transported soil.

Now—with another devastating World War on our hands, we in the United States have very fortunately come to recognize the existence of a serious erosion problem and have under way a great, nation-wide, soil conservation programme.

Farmers throughout the country are becoming increasingly enthusiastic about the results of conservation farming. First of all, it has proven a valuable production measure. With no important exception, soil and water conservation farming measures have resulted in increased per-acre production. The records show that these conservation farming measures will reduce the amount of time it takes to carry on farming operations, and they also reduce the wear on machinery and the consumption of power. Extremely important these days is the saving of fertilizer, which is becoming harder and harder for the farmer to get. Contour farming, at right angles to the slope of the land, prevents rain from washing commercial fertilizers and manure from the fields. Furthermore, nitrogen is added to the soil through soil-and-water-saving rotations which include legumes; and the supply of available plant nutrients is increased by conserving soil moisture and by increasing the content of organic matter. Thus, labour is employed most efficiently and beneficially in the conservation of land, and manpower is not diverted or wasted on unproductive acres.

In the northeastern part of the United States soil conservation farming measures are increasing the per-acre production of potatoes and a variety of truck crops. By improving pasture lands and developing greater producion of hay and forage crops, the conservation or efficient type of farming is also contributing to increased dairy production.

To cite a specific example of how soil conservation increases yield and more than pays for itself, the results obtained on a New Hampshire farm will be given:

A few years ago, R. N. Johnson, a farmer near Walpole, New Hampshire, decided that his potato farm was suffering from the effects of up-and-down-slope cultivation. To operate on the contour, he removed a number of old stone fences. Then he swung his crop rows right across the slope in alternating bands or strips, on the level. Ten rows of potatoes alternated with a protective strip of hay, then ten more rows of potatoes parallelled the hay strip. Some of the hay strips stretched out 1,700 feet or more.

To take care of excess water, he installed more than 30,000 feet of terraces and diversion ditches, and nearly 2,500 feet of vegetative outlets. All this cost about $1,800.

But the returns from the conservation investment on this New Hampshire farm were immediate, continuing—and convincing. The farm is now geared for permanent high production. The cost of capital outlay for conservation improvements was paid for out of increased yields with a single crop of potatoes. In 1939, 483 bushels of potatoes per acre were harvested. This was 76 bushels more per acre than in the best previous potato year. This increased yield, amounting to more than 4,300 bushels from 57 acres in one year, was enough to pay for every terrace, every outlet, every shift of fences, every single item of conservation expense.

I was on this farm when Mr. Johnson was asked, "What would it have cost you if you had not carried out this soil conservation work?"

His answer was: "I would have lost my farm in not more than 5 years. I might have continued farming, but it would have been at the direction of the bank."

The important points are that today Mr. Johnson is not only farming his own farm, but he is producing more per-acre than he did before he adopted conservation methods.

I could go on almost endlessly giving examples of farmers in all parts of the country who have increased their per-acre production through conservation farming. Sometimes the increase is small, sometimes large. Wherever conservation practices have been applied on sloping cropland, with some topsoil still remaining, yields usually have increased.

In the Southern States, it is bringing about a steady shift from destructive one-crop farming to a more diversified agriculture. Thousands of acres of erosion-damaged land have been brought back into production. Crops such as kudzu and lespedeza, which have been so effectively used in doing this are being called "miracle crops" by enthusiastic farmers and newspapermen. They have healed the ravages of erosion and converted formerly desolate localities into profitable dairy sections.

In the mid-western States—throughout the central and upper Mississippi Valley—conservation measures are bringing remarkable results. The per-acre production of corn, under a conservation system of farming, has almost invariably increased—in some instances doubled and even tripled. Better land treatment has improved milk production per cow.

In the range country and in far-western United States, similar results have followed the adoption of conservation farming methods. On the range, we have been able to carry a greater number of livestock per acre and the quality and weight of the animals has been improved, because conservation measures, including grazing according to carrying capacity and better distribution of livestock through the development of watering places, are resulting in a better range. The yields of wheat in the Pacific Northwest have been maintained, and erosion reduced. The orchards are being protected against erosion and silting.

Everywhere that conservation farming methods have been fairly tried, they have resulted in benefits. This is true not only of the United States, but everywhere in the world. The world does not have too much productive soil. The areas of really good land—high-quality, food-producing land—are limited; they are not increasing but are shrinking in size. It has been estimated that 75 per cent of the world's population was undernourished before this global war began. In parts of the world famine had come to be a too frequently recurring disaster among large populations, and this was due chiefly to soil impoverishment by erosion and unwise use of the land.

At this stage of advancement in scientific agriculture, it should be clear to all that people and nations cannot survive without a permanent agriculture, that we cannot have a permanent agriculture without permanently productive soil, and that permanently productive soil calls for adequate protection of the land against processes of soil exploitation and depletion. It must not be forgotten that the quicker erosion is controlled the easier the task and the less the cost. Now that it has been shown how soil can be conserved with practical farm measures, and that soil conservation means increased per-acre yields, there can be no reason for not doing the job as quickly as possible wherever it is feasible.

It should never be overlooked that work on land to keep it productive makes it possible for human beings to enjoy, lastingly, the fruits and benefits of this basic resource, and brings people together perhaps more than any other co-operative endeavor. This is my observation from working across the years with various groups here in the United States, in Mexico, South America, and other places. I am convinced that in the struggle for adequate food—the thing for which man will fight, and die for in a pinch, more quickly than anything else—there is opportunity for men working together throughout the world to come to better understandings. If land everywhere can be made to produce more with conservation treatment—and there is every reason to believe that generally it can be—one of the principal causes for discontent will have been removed or mitigated.

By such action, carried to the ends of the world eventually, one of the basic causes of international strife might be eliminated—through more productive land for food and raiment. Certain it is, other approaches to the proposal of ending wars have led us, 1943 years after the birth of Christ, into the most nearly global of all the long bloody lists of wars, and the one that potentially could come nearest to blasting civilization off the earth.

Well-fed people, living contentedly on well-tended land, are not so likely to be swept off their feet with a lot of hokum about superior races and natural spheres of influence; nor will they be led so easily into wars of aggression.

It must be remembered always that no matter how strongly constructed are our farm buildings, or how well farms may be equipped with

the advantages of electricity and machinery, if the soil is permitted to wash away, all of us will have lost our sustaining capital—the source of food and life. We can replace buildings and machinery and electric lines, but we cannot replace productive land.

It is imperative that the march of soil-impoverishing erosion be halted. The problem is at once individual and national in most agricultural countries; it becomes international in the aspects of good neighbour relations and the Brotherhood of the Soil.

"The Life Blood"

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November 14th, 1942.

The human body consists largely of water contained in a waterproof envelope—the skin. The blood circulates within this waterproof envelope to provide the body cells with the water, food and oxygen which these cells require in order to exist.

The blood has four constituents: the fluid part (or plasma), and three solid elements—the red cells, the white cells, and the platelets.

Blood plasma forms the bulk of the blood. It provides water and food for the cells of the various organs. When food has been converted to a fluid form by the stomach and intestine, it is carried to the cells by the blood plasma. The blood is contained in blood vessels which permit the water of the plasma to pass through their walls. This fluid is known as lymph. The protein in the plasma holds back the water by osmotic pressure. Thus plasma is much preferable to salt solution when used to counteract shock. It remains in the vessels where needed, whereas salt solution pours out almost as fast as it is put in.

The red cells in the blood carry oxygen from the lungs to every cell of the body. They are present in countless millions. One of the remarkable facts about these oxygen carriers is that they are dying. A cell must have a nucleus to live. When created the red cell or corpuscle has a nucleus, but before the cell passes into the flowing blood stream to perform its function of carrying oxygen the nucleus is lost. The red cells live in the blood only a few weeks.

Thus the plasma and red cells are vital to health.

The white blood cells or leucocytes and the blood platelets are vital when disease or injury strikes the body.

The white cells are our first line of defence against bacteria—the most common cause of disease in man and animals. The white cells worm their

way into the tissues to engulf and digest malignant bacteria. When a serious bacterial threat to the body develops, the white cell factory, which is the marrow of the bones, goes into all-out production and the number of circulating white cells is increased from six or eight thousand per cubic millimetre to twenty thousand, forty thousand, or even sixty thousand. A count of the leucocytes provides a simple and fairly accurate means of detecting infection in internal organs and helps to distinguish an attack of indigestion from an attack of, say, appendicitis demanding immediate operation.

The platelets are important because they liberate a substance which causes the plasma to form a solid gel or clot. The platelets first combine to form a plug which fills the hole, and then release a substance known as prothrombin, which is mainly responsible for clotting. Thus platelets are of great value in combatting haemorrhage.

These four elements, then, are vital to the blood. Overproduction or underproduction of any of these items quickly brings trouble. A deficiency of red cells results in anaemia. If, for example, the diet is lacking in iron, red blood cells cannot be properly formed, and fall both in number and quality. Pernicious anaemia results when the stomach fails to produce a certain something necessary for the full development of red cells in the marrow. As is well known, it can be controlled by feeding or injecting liver extract—which serves as a storehouse for the certain something which is lacking.

The blood has other tasks to perform. Regulation of body temperature is effected largely by means of alteration in the blood flow. The countless small blood vessels in the skin play the same part as the radiator of a car—a radiator to which a most sensitive thermoregulator is attached.

Blood transfusion has become of tremendous importance because of the war. The first authentic blood transfusion was performed in England by Richard Lower in 1665, on a dog. Other experimenters ran into trouble, and for 150 years the matter was dropped. At the beginning of the 19th century there was a revival of interest, but fatal accidents were too frequent to justify its use in other than desperate cases. The modern era dates from 1900, when it was discovered that persons can be divided into blood groups and the blood from one group may be incompatible with blood from another group. This was the key to the mystery and soon the procedure was put on a safe and sound basis.

At first transfusion was given for haemorrhage and severe anaemia. At present it is used largely in the treatment of surgical shock which follows operations, burns, and severe wounds and injuries even though unattended by much loss of blood. The essence of shock is a disappearance of the fluid part of the blood, so that the blood vessels are comparatively empty and the heart has not sufficient blood to contract on to keep going. Plasma is ideal for shock, and it is doubly valuable because it can be dried, which reduces bulk and facilitates transportation and preser-

vation; it is restored to its original form by adding a suitable amount of water when it is to be used.

Blood is indeed the life blood. Life as we know it is impossible without water, food and oxygen, and it is the blood which brings these to every nook and cranny of the body, battling infection on the side.

"Controlled Development of Plants"

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November 21st, 1942.

Man has used his knowledge of heredity and environment to mould plants and animals to his personal advantage, but it is only within the past few years that science has evolved a method of creating a new species of plant—for recent work in removing the sterility of hybrids has produced plants more vigorous and stronger than either of the parent species.

It was apparent that sterility in hybrids resulted from inability of the chromosomes to pair up when fertilization took place. If the number of chromosomes could be doubled, this inability would be removed. The answer was supplied in 1937 by the drug colchicine—an alkaloid obtained from the autumn crocus. . By soaking certain seeds a few hours in a solution containing colchicine, the seed will produce a larger, stronger and hardier variety of plant.

In the last few years, by the use of colchicine, the chromosomes have been doubled and sterility removed in a number of hybrid plants, of which the most important economically are wheat, cotton, tobacco and corn. Iowa is planted 95 per cent from hybrid corn seed which grows more rapidly and gives a greater yield.

Life processes and evolution in plants are becoming increasingly subject to conscious control by genetic experimenters. Indeed it would be no exaggeration to say we are on the verge of learning how the hereditary processes work. But the application of this new genetics to man is still a thorny problem.

There is no adequate evidence that man today is a better animal physically or mentally than he was at the dawn of history. While man's biological evolution during these 5,000 years and more has seemed to lag —and at the present moment has appeared to many to have been thrown into reverse—man's environment has changed markedly even within our own lives. Conscious control of human heredity, though a consummation to be sought, will at best be slow, even if our genetic knowledge were ade-

quate for the task. Changing man's environment gives promise of more rapid betterment of human individuals, and in this effort we are far from reaching diminishing returns.

Indeed, today it looks as if man has a greater moral sense than ever before. It is beginning to look as if it is this moral element that will sink the Japanese.

"Population Movements in Wartime England"

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November 28th, 1942.

The future belongs always to the living generation. England is assuring her future by caring in a new and decisive way for the physical and mental needs of her very young children. Under the rain of bombs and the threat of invasion she carried out a revolution in education, and established nearly 3,000 nursery schools for children two to five—the beginning of a programme which will include all children of that age group in the United Kingdom. It is not a war measure. The government has declared its intention to continue this new type of schooling after the war, and it will become an integral part of English culture.

The history of this movement is a tribute to Canada and Canadians. On invitation of the English authorities, Dr. Blatz, head of the Institute of Child Study at the University of Toronto, and five members of his staff, went to England last May and there established a training and demonstration school in Birmingham along the lines of the nursery school here.

In three months some 360 workers were trained. Dr. Blatz and three of the staff returned in October. Their places were taken by five other Canadian workers chosen by the Institute here, so that Garrison Lane Nursery Training School in Birmingham, which has been adopted as a model for the nursery schools of Britain, is staffed by Canadians and promulgates a scheme for pre-school education developed in Canada.

In England, with no previous experience in this type of work, upwards of 3,000 nursery schools equipped to care for 100,000 children were established in two and one-half years of war. Once under way, the transition from the old "minder" type of nursery school was swift and efficient. The whole programme is under direct supervision of the central government, and the budget for this pre-school education now amounts to the quite respectable sum of $50,000,000 a year. The number of schools is growing rapidly. Many schools have waiting lists equal to or in excess of

their present registrations. Prefabricated schools are built and transported to selected sites as rapidly as supervisors may be trained.

Two types of nursery schools have been established. There are residential schools which keep children for twenty-four hours a day; these are of emergency character for evacuee work and will be discontinued. Most of the schools, however, are for children whose mothers do war work. The children are left at 8.30 each morning and called for at 6.30. There are forty children in each school, under the supervision of four workers—two fully trained and two partially trained.

Following the war there will be no cultural or educational restrictions on any child in England. The new system will carry over and two years will be the recognized age for children to begin school. Each child will enjoy educational, nutritional, medical and recreational privileges formerly accorded only to families in the upper income brackets.

This pre-school education will emphasize self-discipline, and encourage children to get along together. This will tend to create the type of citizen who can take a useful part in community life. England has accepted the new system as a social device for breaking down class privilege. It is not a question of education, such as teaching the alphabet, but of teaching concentration, self-discipline, and consideration and respect for others without losing self-respect.

Canada is far behind Great Britain in recognizing the need of early education and care for children under school age, not only from the standpoint of the war emergency, but as a long-term programme to give every child an equal footing from babyhood in education, feeding, recreation and medical care. The layman is apt to place undue emphasis on heredity, but experience in these nursery schools established in England shows conclusively that environment influences can change in a short time not only appearance but behaviour.

State medicine for children in Canada is coming soon. Great Britain has made a start. Canada could follow the overseas lead of providing a noon meal for children. The Department of Education in Britain is the biggest restaurant owner in Britain. Some such system must come in Canada because it is the only way we can be sure children will be well fed. Money alone is not sufficient. Malnutrition due to poorly selected diets can be found in all sections of the population.

The mass migration of children from blitzed areas has brought a realization on the part of British parents that the old way of life is not good enough for their children. They are turning to the organized and specialized help which can come only from the state, and the state is accordingly giving direction to the great movement toward enlightened child education. In Canada, too, if we are to measure up to the opportunities of the morrow, the state must play a greater part.

Children must be trained to be skeptics rather than trained to believe everything they are told, without question. The enquiring mind is the open mind, the scientific mind. Social science, if it is science, spells progress in social relations, just as physical science has produced great technological and industrial advances.

The concept of "family" must be examined more objectively. In a democracy the family was considered the sacred social unit. A family may be defined as a unit which accepts responsibility for the training of the young. Some of that responsibility might well be delegated to others, if others are more skilled. The increasing specialization of society indicates the trend. Whether parents are best able to look after the manifold cultural, physical and intellectual needs of their children is certainly debatable. Whether the day will come when parents will be able to look after their children with no outside assistance whatever is a question for the future to answer, but that day certainly is not here now.

"Saving Hydro Power For Victory"

THOMAS H. HOGG, B.A.Sc., C.E., D.Eng.

Chairman and Chief Engineer, Hydro-Electric Power Commission of Ontario.

December 5th, 1942.

In the year prior to the war, Hydro prepared in case war should materialize, to supply the resultant expansion in the requirements of industry. But now, as in every other department of life, we are asked to save power that victory may the sooner be ours. Even the present manpower crisis is related to electric power, as electric power enhances manpower and we must, accordingly, extend our power resources to the utmost.

Of course there are many ways in which our technical men may effect savings in electric power and you may be sure these savings are being effected, but the general public too has a signal opportunity to participate in these savings by exercising common sense and every-day frugality.

Last year, in Ontario, the average home used five times as much electric energy as it used at the end of the last war. We are asking the public to cut consumption by one-fifth or, in other words, to reduce it to an amount which is still four times as great per domestic customer as it was in the last year of the last war.

Those appliances which depend upon the heating effect of electric current for their serviceability use up most current. Thus the iron takes 8 times as much power to operate as the radio; and the refrigerator requires only one-quarter the power that a toaster requires. The electric

range needs 8 horsepower to operate; the washing machine—perhaps the most labour-saving device electricity has brought to the housewife—requires one-quarter horsepower. Therefore watch your electric range. Follow all the hints given in the publicity material which has been issued. The electric range is where the house-wife can make the greatest saving in electricity.

Use the range, water heater, electric grate, air heater, and also lighting sparingly. Do not be afraid to use your vacuum cleaner or your washing machine because these great labour saving devices use very little electricity.

Exercise in all things frugality and common sense till victory has been achieved. Hydro represents the way of life we are fighting for. When our fighting men come home, we must make sure they return to a Canada worth living in. Many of the material things of life can be provided more easily and distributed more widely where an ample supply of electrical service at low cost is available. The Hydro-Electric Power Commission of Ontario, during its three decades of service to the citizens of this province, has replaced the profit motive by that of maximum service to the greatest number at the lowest cost. That this is no idle phrase is shown by the support Hydro received from all parties and classes. It renders our citizens an efficient, co-ordinated service unsurpassed in any comparable territory, and at rates which encourage the abundant use of this great natural resource . To-day it is harnessed to the chariot of Mars, but in the post-war period when victory has been gained, Hydro looks forward to an era of even greater service. But for the time being let us all *Save Hydro Power for Victory.*

"Synthetic Rubber"

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Sharples Chemicals Inc., Philadelphia.

December 12th, 1942.

The vital need to produce sufficient synthetic rubber for our armed forces needs no elaboration, for 97.2 per cent. of the world's productive capacity for natural rubber was concentrated in the Far East, and—with the exception of plantations in British India and Ceylon—is outside our sphere of influence for the moment. The Baruch Committee accordingly recommended that 845 tons of Buna S synthetic rubber be produced each year, and this gigantic undertaking will tax the ingenuity of our scientists and engineers.

The first man to examine rubber was the immortal Faraday, who established the formula as C_5H_8. Gradually the chemistry of rubber was

investigated and when the price of natural rubber went up to $3 per pound in 1910, research was greatly stimulated. During the first World War Germany produced some synthetic rubber, but of a very inferior sort. Progress was made only after the chemists abandoned the time-honoured approach of trying to duplicate the exact molecular pattern of natural rubber. Even to-day we have no truly synthetic rubber which is a duplicate of the natural material, although we have materials which so far as performance is concerned, are duplicates. Prior to the outbreak of the second World War, the Germans, Russians and Americans did valuable research on synthetic rubber.

The principal raw material in the manufacture of synthetic rubber is butadiene. This may come from a petroleum source or an alcohol source. When butadiene is emulsified in water with styrene, and processed, rubber results. It is estimated that Buna S rubber might be produced at a cost of 15c. per pound. If the war continues for two years, we will have on this continent a productive capacity approaching twice our prewar requirements. The political implications are enormous. Never again shall we in this hemisphere be forced to pay cartel prices for crude rubber.

The effect on agriculture will be most marked if we find a way in which to produce alcohol at less than 10c. per gallon. If that could be done from say, wheat, there would be no wheat problem at all.

Synthetic rubbers have varying qualities. The rubber compounders, by using several synthetic rubbers, will be able to fashion rubbers to meet every requirement. In this way the efficiency of industry will be much enhanced.

"The Development of Reforestation in Ontario"

FRANK S. NEWMAN, B.Sc.F.

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December 19th, 1942.

The main purposes of reforestation are economic forest crops and the prevention of soil erosion. Woods are responsible for checking soil erosion by forming windbreaks, by holding together the precious top soil so that it will not run off with rain, and by checking rivers from overflowing into nearby farm lands.

Reforestation has been carried on for centuries in Europe and we in Ontario are still far behind European standards in the proportion of forests to arable land. In Germany, for example, the proportion is maintained at 25 per cent., not for the sake of the timber only, but to benefit other agricultural crops by the retention of water in the soil and prevention of

erosion, and creation of general favorable climatic conditions. In Belgium, the most densely populated country of Europe, the proportion is 18 per cent. In Ontario the proportion is about 10 per cent.

The Provincial Forestry Station at St. Williams was established on sandy waste lands in Norfolk County in 1909. Although this station has sent out about 40 million trees in the past ten years, the use of woods exceeds natural regeneration and the present rate of reforestation combined, and consequently if economic balance is to be maintained, the rate of reforestation will have to be stepped up to keep pace with depletion. On the 3,800 acres of the St. Williams farm there stand 40 million trees, of which 10 million are ready for free distribution this spring to any one who wants them.

The St. Williams station is itself an object lesson in reforestation. The acres were purchased in 1908 as useless waste land at $5.00 to $10.00 per acre. Today, through reforestation, it is worth $100 an acre. From 15 acres of this land this year came a $600 crop of timber, produced only from the thinnings. No real timber was touched and every tree was planted 25 years ago.

Reforestation need be no complicated problem. For example, unfertile plots abounding in Norfolk, Elgin, Brant, Haldimand, Simcoe and Durham counties might be planted with Scotch pine, the common Ontario Christmas tree. In six years the owner would be able to harvest a profitable crop that would net him good money. Not only would the crop pay, but it could be replaced so that every year a crop might be cut.

The economic value of reforestation has proved itself time and again in actual practice. An Ontario tobacco company saw fit to plant 103,000 trees on 49 farms as windbreaks. Since the planting, tobacco crops have improved and consequently income has been raised. Thus reforestation has not only a direct, but an indirect value.

The demand for forest products, accentuated by lack of metal through war industry, will be even greater when peace comes. Therefore there is every reason why a policy should be adopted to conserve and replenish forests for their own sake, as well as for agricultural reasons.

The Coloration of Animals with Special Reference to Change of Colour"

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January 9th, 1943.

Animal coloration may be classed under three heads; concealing coloration, coloration for advertisement, and disguising coloration (including mimicry).

Concealing coloration is well represented throughout the animal kingdom, but especially so among insects. Concealing coloration may be protective to hide the animal from foes, or aggressive to permit the animal to pounce successfully on unsuspecting prey.

Coloration for advertisement is well exemplified by the bumble-bee whose brightly-marked body serves to advertise its vicious sting. And who has not heard of the skunk? Almost everyone would agree that in his case "it pays to advertise."

Disguising coloration is best seen in insects. The common Monarch Butterfly has a rank and disagreeable odour repellant to birds and other predacious animals. The Viceroy Butterfly imitates the markings of the Monarch. Although it has no such vicious taste, it profits vicariously by its resemblance to the Monarch.

Quantitative experimental evidence on the value of protective coloration is now being obtained. In one case 2,672 fishes were offered as prey. Of these 1,150 were reckoned as casualties, 395 (or 34%) were of less conspicuous varieties, and 755 (or 66%) of more conspicuous ones. Experimental evidence of this kind obtained from either laboratory or field can settle many current problems of animal coloration more conclusively than even the most wordy discussion.

Animals with a remarkable capacity for rapid colour change have long been known. Outside a few sporadic instances, the animals that show this remarkable capacity are found in three independent groups—the cephalopods (devilfishes and squids), the crustaceans (shrimps, prawns, crabs, etc.), and the cold-blodded vertebrates (fishes, frogs, salamanders and many of the reptiles, especially the lizards).

The majority of fishes can be shown to exhibit more or less change of colour. The squirrel fish of Bermuda will change from pale to dark (or the reverse) in a few seconds, whereas others, such as the common New England catfish, require from one to several days to make these alterations.

Colour changes are brought about by readjustments in the pigment content of the colour-cells in the skins of these animals. The most usual

kind of vertebrate colour-cell contains granules of black pigment. In the pale condition, the pigment is collected about the centres of the colour-cells. In the dark condition it is scattered throughout the cell. The shifting of pigment back and forth is what changes the tint of the fish.

In addition to the black colour-cells, many fishes possess true colour-cells with characteristic pigments which enable them to change not only from dark to pale, but to assume yellow, green, blue or even red tints.

How these colour changes in fishes are controlled has been a problem for a century past. It was at first believed to be due mainly to the nerves, yet studies of chromatism in the frog led to the conclusion that in the frog nerves played a wholly insignificant part in colour change if in fact they played any part at all. Evidence was adduced to show that the dark colour was due to a hormone produced by the pituitary gland, while the pale colour was due to lack of this substance. From this and other work it was concluded that though the colour changes in fishes and reptiles were dominated by nerves, those in amphibians were essentially hormonal.

This novel and somewhat anomalous situation stimulated further work on colour changes in the lower vertebrates, particularly the fishes. Research shows that in many common fishes there is good evidence that the colour changes are at least partly under nervous control. Indeed, it is believed that chromatic nerves contain at least two sets of fibres, one, the concentrating set, the other, the dispersing set. Further research indicates that some fishes may possess other means of controlling the black and white colour-cells than the two sets of nerve fibres. If such another activator were present it might well be the secretion of the pituitary gland, intermedine.

The hormone intermedine is produced in the pituitary gland of the brain, whence it is carried in the blood and lymph of the fish to the colour-cells of the skin, the pigment of which is thus stimulated to disperse. This is a very simple and direct way of applying an activating agent to its responding part.

How do the two sets of chromatic nerve-fibres stimulate colour-cells? These two sets of fibres belong to the autonomic nervous system and might well be supposed to act on the colour-cells through the two activators so common in this system—adrenaline and acetylcholine. Experimental evidence corroborates this. Indeed a prodigiously small amount of acetylcholine (1:13,000,000) will give an experimental reaction.

In summation, it is suggested that concentrating nerve-fibres act on colour-cells through adrenaline and dispersing fibres through acetylcholine, and that therefore the colour-cells must be subject to much the same type of stimulation by nerve-fibres as by intermedine, in that in both instances there is a direct application of a dissolved activator to the colour-cell.

This tentative view leads to two important conclusions. The first is that the frequently made distinction between stimulation of colour-cells by

hormones and by nerves is of very little significance, for both methods are in reality the same and depend upon dissolved materials applied to the colour-cells.

The second conclusion is that the type of stimulation in the chromatic system falls exactly in line with what is being developed at present for the nervous system in general, viz., that one nervous unit, be it sense cell, nerve cell, or appended cell, is stimulated by another not through purely electric disturbances that pass from one unit to the next, but by substances such as the three herein named. These substances are generated by the discharging unit and activate the receiving one.

According to this view, such substances are the universal means of passing impulses from one element in the nervous system to the next, and are thus of first importance in the physiological integration of nervous activity. They have been variously called chemical activators, neurohormones, transmitters, neurohumors and the like—but the substances thus designated all act to the same end, the transmission of nerve impulses from one nervous unit to its neighbour.

It is gratifying to observe that the study of the colour changes of animals supports this general conception of nerve activity which is perhaps one of the most important steps in the modern study of the nervous system—that system of organs which has more to do with making us what we really are than any other system in our whole physical organization.

"Aptitude Tests and their Application in Wartime"

COLONEL WILLIAM LINE, B.Sc., M.A., Ph.D. (Lond.).

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January 16th, 1943.

The primary purpose of personnel selection is to estimate the recruit's ability to learn and to describe his aptitudes and abilities, etc., so that his placement in the Army may be as effective as possible and consistent with his own interests and aspirations. The approach is by individual examination and interview at the reception level, with a continuous follow-up as the soldier proceeds through each stage of training. Broad recommendations as to placement are made at first and these become more refined and specific as training becomes more specialized. A continuous record of the individual's abilities and progress accompanies a soldier's documents and is available to Training Officers.

There are some 700 officers and other ranks engaged in personnel selection in the Canadian Army in Canada. The officers, known as Army Examiners, were selected on the basis of their psychological training,

army knowledge, and experience in personnel activities in industry and education.

There is an obvious need for scientific and careful selection in any modern army. The degree of complexity and differentiation involved in modern military organization, coupled with the shortness of time available in which to build up a significant military force points to the necessity of efficient use of manpower without recourse to mere trial and error. The Army is faced with the task of transforming a large body of civilians, both men and women, into effective and highly skilled members of a complex fighting machine in a very short space of time. To do this it must be flexible enough to rid itself of many of its ancient traditions and purposeful enough to plan its organization as efficiently as possible.

When the recruit presents himself at Reception Centre the relevant factors of his background and present ability are applied first to the problem as to whether he is suitable to participate in military training or not. He is examined by means of psychological tests and interviewed with a view to determining what his past history of achievement has been and what aspects of his experience are most likely to contribute to one form of military service or another. If he is handicapped by lack of education, although otherwise intellectually suitable, the Army makes provision for him to combine military and educational training so that he will be able to take his place in the normal training stream. If his services are deemed to be more valuable to the national effort as a specialist in industry or working in agriculture, etc., he is so advised. If acceptable to the Army he is allocated at this stage to training in a particular arm of the Service and his potentialities are noted. All such allocations take into consideration the man's personal preference as well as his abilities and are, of course, subject to the needs of the Army as laid down in a current quota.

At his first Training Centre where he learns the initial adjustment to military life and the basic skills required in all forms of Army activity, his allocation is checked and his progress noted. As he proceeds to the advanced training pertinent to his Arm the type of specialty that he will take up is similarly determined by further tests and clinical procedure. At all stages the Army Examiner acts as personnel adviser to the Commandant and in matters pertaining to progress and placement consults with the Training staff.

The work of the Army Examiner is closely co-ordinated with that of the psychiatrist. At Reception Centre all men whose ability to fit smoothly into the training stream may be in doubt are referred to the psychiatrist who is responsible for making the appropriate recommendations to the Medical Board. Similarly in all problems of discipline, retardation and change in placement, the Army Examiner and the psychiatrist work hand in hand. As the more significant specialties and responsibilities involved in military service are analyzed beyond the point of such factors as intelligence level and educational background, it becomes increasingly clear that

placement decisions involve psychological and psychiatric distinctions. For example, the careful canvass of the officer potential is a matter where it is almost impossible to differentiate between the function of the Army Examiner and of the psychiatrist.

From what has been said it would appear that any arbitary recording of fact concerning an individual and the subsequent manipulation of machine records for purposes of classification of soldiers is foreign to the system involved in the Canadian Army. The process of selection is a continuous one that is always done clinically and that involves at all stages participation of the individual soldier whose programme is being mapped out. The continuous recording and reporting on the individual's progress forms the constant source of valuable information to all officers concerned with the welfare of their men. The same type of information should be of value similarly during the period of demobilization when the induction of the recruit into the Army is turned into reverse gear.

"Plants and Civilization"

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January 23rd, 1943.

Until the discovery of fire led to the use of cooked cereals, the diet of primitive man must have been very meagre indeed. But once the value of cooked cereals became apparent, this led to the sowing of grain and to the development of agriculture which probably came into being independently in the three main areas of the earth, viz., wheat in the Mediterranean basin, rice in Asia, and maize in America. In each case a different type of civilization developed.

While cereals are basic in agriculture, the search for such plants as spices and sugars has played an important role in intermingling these various civilizations, because the search for spice and sugar has indubitably been the main motive behind the exploration of the New World and Asia. Thus it has been responsible for the building of empires.

In general we find a plant is never fully appreciated in its place of origin. For example, sugar cane was not an important plant in India (its habitat) or in Europe. But when the Spaniards introduced sugar cane into the West Indies, the rest of the world became sugar conscious, providing a market which has developed into the tremendous sugar industry of today.

It is curious to reflect that sugar once occupied so dominant a place that it nearly lost Canada to the Empire. When a land settlement was

drawn up following the war between England and France, England had her choice between the whole of "useless" Canada and the little island of Gaudaloupe, luxuriant with sugar cane. But for the intervention of Benjamin Franklin, of the then American colonies, England would have chosen the island!

Plants have influenced world history in other ways. The Asiatic conflict can be attributed partly to the soya bean which, because of varied industrial uses, has become indispensable to the trade of Japan, who, searching for more territory in which to grow the soya bean, decided upon Manchukuo.

In other ways too, crops have completely changed the history of the people who cultivate them. The potato was unknown in Europe before the discovery of America, but it soon became the staple food of Ireland. When potato blight attacked and destroyed crops there, causing the Potato Famine of history, large numbers sought a new home in America, thus aiding materially in the development of this continent.

Our present industrial age owes everything to the rubber plant, and to coal, which is the compressed remains of plants. Plant specialists are working on rubber substitutes. There is no reason why a plant cannot be developed which will produce first quality rubber for us here. It may be too late to help in the winning of this war, but it will assuredly help to build our wonderful civilization of the future.

The great mystery of plant life is how a plant manufactures its food from air, light and water, through the mysterious functioning of chlorophyl. There is reason to believe that eventually one will be able to manufacture sugar from starch right in one's own kitchen, using some synthetic form of chlorophyl.

Today plant specialists can breed new plants suited to specific climates and localities. What this will mean to Canada, with her vast acreages in the far north and elsewhere, staggers the imagination. Canada has already profited through the development of special wheats which enabled the prairies to be utilized to the maximum. In this connection Marquis wheat deserves special mention, for it made possible one of Canada's richest crops on the hitherto-ignored prairies.

"Food and Drug Control in Canada"

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January 30th, 1943.

"Food and Drug Control" means the establishment and maintenance of standards of quality, and the prescribing of methods which will protect the consumer against dangerous or fraudulent methods in the preparation and marketing of food and drugs. Our present Canadian act was passed in 1920, and subsequent amendments have been necessary to keep pace with the rapidly advancing biological sciences. There is an impartial organization set up within the Department of Pensions and National Health whose job it is to administer the act and the regulations. The act is built largely around the words adulteration and misbranding.

Food adulteration is an old story. It reached its most dangerous peak during the latter part of the last century when it was discovered that the liberal use of antiseptics would prevent food spoilage. Nationwide distribution of foods became big business and some of the rugged individualists of those days did not care a hoot what happened to the consumer as long as they were able to market the chemical messes they were pleased to call "food."

Fortunately times have changed and such practices are no longer tolerated. Unless the immediate and long-term cumulative effects of a chemical are well understood, it is looked upon with grave suspicion as a constituent of food. Great strides have been made in the use of heat in connection with canning, and freezing and drying, as methods of food preservation. This has reduced the urge to use preservatives and thus eliminated many of the control officer's bugbears.

The control of drugs may be considered under two headings: those which may be analysed by chemical methods, and those requiring biological methods of test. The first group comprises the chemicals one usually calls drugs. The principal task in their control is to see that the contents of the bottle live up to the claims made on the label. Fortunately this task is simplified owing to the existence of official lists of drugs, together with their specifications, which are known as "pharmacopoeias." Market samples of drugs are judged by the specifications laid down in the pharmacopoeia indicated on the labels.

The only way to avoid disclosing all the ingredients of a bottle of medicine is to register the formula under the Patent Medicine Act, which makes it possible for control officers to supervise the composition of these preparations. In all other cases the label must bear a true description of the contents.

The determination of safety and potency of preparations which require to be assayed by biological methods presents special problems. Chemical

analysis will not reveal their activity and thus is useless for the purpose. Most of them are given hypodermically, and are of such a nature that germs will grow in them, or at least remain alive, which means that special cultural tests must be applied to ensure sterility.

Bioassay—which is the use of living cells to measure potency—is a rapidly growing branch of the science of biology. The first point to remember is that no two animals react to the same degree to the same dose of one of these preparations. For this reason it is necessary to use a large number of animals to determine the average response on which the calculation or potency is based. Nowadays mathematical science is applied to the problem and results are not acceptable unless the limits of error are known.

Another feature of bioassay is the necessity of having standards for use as yardsticks in measuring new preparations. In many cases these are international and the result of one of the League of Nations' most successful enterprises.

"Population Relations Between Canada and the United States"

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February 6th, 1943.

It is interesting and instructive to contemplate population movements between the United States and Canada, because by so doing we may understand the past and find a key to the future.

There are today about 345,000 American-born people in Canada, and about 1,250,000 Canadian-born people in the United States. Thus the Canadian-born in the United States outnumber by four to one the American born in Canada. And, considering the relative size of the census totals, our contribution to United States population figures is forty times that of the United States to ours.

Further, the Canadian-born in the United States are as different in statistical behaviour from the American-born in Canada as one could possibly imagine.

The most striking contrast between American-born in Canada and the Canadian-born in the United States is in the matter of geographical distribution. Of Canada's 222 counties, not a single one but contains persons born in the United States, regardless of whether the group local is

cool or sunny, arid or well-watered, English or French-speaking, rural or urban, east or west.

The opposite is true of Canadian-born residents in the United States. Three-quarters of the total are in New England and the north-central states, and most of the rest are in New York and California. Eleven states have less than 1,000 Canadians apiece. Even in cities they congregate in blocks. Of 1,400 wards in 107 cities, 116 have more Canadians than all the others put together.

The reason for this disparity of distribution lies in the different motives for migration. American-born come to Canada largely as individualists. There has been no general population movement. The nearest approach to such a movement was the trek to the Northwest in the first decade of this century, which led the noted journalist, Goldwin Smith, to prophesy the Northwest will be American. But history contradicted his dictum. The west is only seven per cent American-born and twelve per cent of American descent.

In contrast, the movement of Canadians to the United States has been more one of population. The historic exodus of the last century is the largest single episode in the history of our Canadian-American population relations. In the eighties, for every 1,000 Canada added to her own native-born population she added 717 to the Canadian-born population of the United States. In the twenties of this century the proportion, though lower, was still high—223 to 1,000.

The largest numerical concentration of Americans is on Montreal Island, where there are 23,000. But in southern Alberta 18 per cent of the total population is American.

By the 1931 census, there are 8,000,000 native-born Canadians out of a total population of over 10,000,000. Of the remaining 2,000,000 or more from other countries, the largest single contribution has been made by England (725,000 immigrants), with the United States second (345,000), and the Scots immigrants (275,000) running third.

The American-born newcomer in Canada is most assimilable, next to those born in other parts of the British Commonwealth. This is shown by records of the American-born readiness to become naturalized and intermarry with people of Canadian and British birth.

One interesting example of population movement is its effect on language. Over a million Canadians (47 per cent of Quebec, in fact) speak French alone. The United States virtually compels all its native-born of every race to learn English. Canadian-born French living in the United States numbered 360,000, according to the United States census of 1930. Nine per cent of these were still unable to speak English. But of their nearly 600,000 children born in the United States, only one-half of one per cent could not speak English. About 55,000 such children have since come back to Canada, and though in our census 47,000 declared French

their mother tongue (i.e., that learned at their mother's knee and usual at home), all but a very few could also speak English.

A flexible immigration policy based not on supposition but rather on scientifically ascertained facts, will lead to the continued development of Canada. The general problem of population exchanges between nations will be a basic factor in post-war politics, and should accordingly be treated with the utmost detachment. The inflow of American capital to certain Canadian industries is partly responsible for the American influx. An empirical approach and flexible policy is most to be favoured.

"Iran (Persia)—the Country and the Architecture"

MYRON B. SMITH, B.F.A.

Chief, Iranian Section, Library of Congress, Washington, D.C.

February 13th, 1943.

When we turn our thoughts to Persia, or to Iran, as the Persians have always called their country, it is its colourful pottery, miniatures and rugs that come to mind, and with them the romantic picture of young poets, reciting in moonlit gardens their verses of the old, old tale of *Gul u bulbul* the song the nightingale sings to the rose.

If such be your poetic image of Persia, then it is my unpleasant duty to disillusion you, and this because you will understand the architecture of Persia only as you appreciate the social, geographical and climatic conditions which produced these gardens, mosques, minarets, dwellings, villages, and cities to which we shall turn our attention this evening.

* * * * *

The Persian plateau is about 5,000 feet above sea level and is traversed and rimmed by mountains which tower above the plains. Mountain and plain reflect the light from the ever blue sky to the constantly changing horizons. Rainfall is so scant as to be almost non-existent. The country is desiccated, the dust can be choking, the contrasts in temperature are violent. At all seasons the thermometer drops from 35 to 40 degrees Fahrenheit at sunset. Thus the traveller may be seared by the sun, scourged by the wind, suffocated by the dust and congealed by cold, all within 24 hours. To pass through so vast and grim a country is a shrivelling experience. The traveller cannot but feel his own smallness and insignificance. He reaches the last turn in his road covered with dust, parched with thirst, bruised by fatique, chastened, and most grateful to Allah for his safe arrival. If never before, he realizes then why the Prophet made pilgrimage a means of obtaining divine grace.

But Persia has a gaunt, unforgettable austerity. The ever visible mountains may be comfortless but they testify to the might of the Uni-

verse, to its terrible beauty. Once known, it is impossible to forget this country of vast distances and lonely grandeur, of mountains from Chinese landscapes edging endless plains of shimmering heat, of villages green-tufted in high mountain valleys, of cypress-shaded gardens with pools of rushing water at the end of long days, and the cool silence of nights bright-lit with stars. That Iran of enchanting memories brings nostalgia to any one who has had the good fortune to know it. But to know it one must speak Persian, take time, and in courtesy try to outdo the Iranis.

* * * * *

As is known from the well published mosques of Cairo and Istanbul, Islamic architects generously ornamented their handiwork with inscriptions, inscriptions which as historical documents are rivalled only by coins. In addition to rich hoards of epigraphical material, the comparatively unknown Islamic monuments of Iran contain problems of arch, vault, dome and stalactite construction, a wealth of calligraphic and ornamental details in faience, pigment and stucco, and the very finest examples of brickwork.

The simple buildings in town and country are pure examples of folk art. Built for the most part of mud brick and plastered top and sides, with a mixture of mud and broken straw to turn the weather, these simple structures furnish the needed shelter on this mile-high plateau from the desiccating heat of the summers and the bitter cold of the winters. These buildings, generally vaulted, are remarkably sturdy and, because of the dry climate, are amazingly enduring. They are constructed with a minimum of wood, the use of this precious material being confined, as a rule, to doors, door frames, windows and gutter spouts.

From the low sky lines of many Iranian towns and cities, rise the noble perpendiculars of slender minarets, from the tops of which used to come, five times a day, the muezzins' wavering "Allahu akbar!" that called the Faithful to prayer. Nearly all the minarets are centuries old, have long winding stairways within, and are built, for the most part, of baked brick. Yet even these attenuated structures were occasionally built of mud brick, so strong is the local tradition for the use of this simple material. The minarets have long ceased to be used for the call to worship and today practically nobody goes to the mosques, a most regrettable state of affairs for the reason that little of worth is being added to Iranian philosophy or daily life to replace the moral teachings of the Muslim religion.

* * * * *

It was the French architect and engineer, Marcel Dieulafoy, who declared, late in the nineteenth century, that in Iran could be found the origins of Gothic architecture. This bomb ignited a controversy that continues to smolder. In support of this thesis it was recently proposed that among the elements of Gothic style to be found in Iranian Islamic buildings are pointed arches, ribbed vaults, flying buttresses and concentrated supports including cruciform piers and clustered shafts. Interesting as the theory of Iranian origins of Gothic has appeared to the lay-

men, few scholars have shown willingness to accept it on the basis of the exposed evidence, such as superficial observations and photographs, unsupported by accurate dating and analysis of construction. In architectural archaeology some progress in method has been made since the days of Ruskin. Poetic prose can scarcely take the place of a rigorously disciplined dating and a knowledge of construction. In the case at point, the various "Gothic" elements found in Iran have nothing to do with the system of construction which we call Gothic, and which may be briefly defined as a roofing system of ribbed ogival vaults poised by means of counter-thrusts on slender piers of great height. Such a system of construction as this is the very opposite in fact and in spirit from that used in Iranian Islamic buildings. To be sure, there are vistas of pointed arches and piers in the great Friday Mosque at Isfahan which are reminiscent of the Gothic cathedrals, while the Kaisariyyeh Bazaar in the same city has vaults which, at first glance, suggest fan vaulting. But in these and other monuments it is the pointed arch, long the favourite in Iran and itself of Near East origin, that confuses the eye and wrongly suggests the Gothic analogy.

* * * * *

It must be mentioned, before leaving the now negatively determined problem of Gothic origins in Iran, that its protagonists, while vainly searching for pre-Gothic examples, failed to note certain true "Gothic" vaults and piers. These are ribbed, ogival quadripartite vaults supported by wall ribs and piers. The examples satisfy all criteria of simple Gothic construction. To connect these embryonic ribbed vaults with the complicated and highly sophisticated Gothic structures of Europe is impossible on the grounds of dating alone. None observed can be dated earlier than the 15th century. Thus they must have developed independently in Iran and centuries after Gothic construction originated in Europe. But what is interesting to us is that these "Gothic" vaults are being built in Isfahan today.

[The lecturer then exposed a series of slides showing this type of vault under construction.]

* * * * *

It is only during the past decade that a thorough study of the religious buildings of Iran has been possible. For this privilege scholars are indebted to the Pahlevi dynasty, which has opened for scholarly research the heretofore closely guarded mosques and shrines of Iran. His Imperial Majesty Muhammad Shah, following the example of his father, takes a personal interest in the restoration and repair of the historic buildings in his empire. Early in his reign Riza Shah had brought to an end the archaeological monopoly held since 1897 by the French. Under the provisions of the 1930 Antiquities Law the standing monuments as well as the sites were put under the newly organized Iranian Archaeological Service. Iran is now one of the newest, most generous and most promising countries for

archaeological research, this not only for the digging archaeologist but also for the architectural historian.

* * * * *

The time has come to tie up the *pishkesh* and respectfully place it in your hands.

We have been looking at a country which Nature made desolate but which man has managed to make habitable and beautiful. And this by use of the precious water from melting snows, in those mud-walled gardens that bring a fraction of the vast desert down to a scale at which the Persian can be at peace. We have seen the garden dominating not only the private lives of the people but also giving the scheme for mosques and madrasas, to fit them into that out-of-door life which the Persians enjoy. But always, to divide the desert from the sown, the civic from the domestic activities, there is the high wall, the dust-coloured, mud wall of the garden. The verses of Djalal-ed-Din Rumi and of the other Sufi poets suggest that the Persians made still another division, that between the outer life of a good Mussulman and the inner burning to be One with God.

We have been looking at green gardens in a desert land, orchard gardens, tiny domestic gardens that are little more than an eye to the turquoise Persian sky, royal gardens, hunting parks and pleasure gardens,—retreats to go to for the first day of spring and to linger on in until autumn turns to winter and the leaves of the plane trees float on the placid pools. We have seen that the vastness of Persia created a psychological necessity for the garden, a walled enclosure wherein a human being can feel himself at peace with a part, at least, of the Universe. We have found the garden represented in the arts of miniature painting, of textiles, of pottery, of rugs, and in the architecture we have found the garden to be the nucleus of every plan, from the simplest house to a mosque or a palace.

With these findings in mind, let us look at the last slide, a miniature painting of the Iranian hero, Rustam, asleep on his travelling rug. His fabulous and faithful horse, Raksh, defends his master from a hungry lion. Rustam, unconscious of this episode, is dreaming. His dream, of course, is of a garden, not the Gardens of Paradise promised the Faithful, "the gardens underneath which rivers flow," but reclining on the sun-baked earth of the Persian desert, Rustam dreams of such a garden as only a desert-born Persian artist could imagine. Has Rustam's intoxication of the senses merged into an intoxication of the spirit? Such a merging, Laurence Binyon has pointed out, is visible in Marvell's "Thoughts in a Garden,"

> ". . . . where, at first entranced and ensnared among the voluptuous fruits and scented flowers, one soon passes into a deeper experience;
>
> 'the mind from pleasure less
> Retires into its happiness
>
> . . . .
>
> Annihilating all that's made
> To a green thought in a green shade.' " [1]

1. Laurence Binyon: The Spirit of Man in Asian Art, (1935), p. 136.

"The Alaska Highway"

R. N. JOHNSTON, B.Sc.F.

Forester in charge of Aerial Surveys, Department of Lands and Forests of the Province of Ontario.

February 20th, 1943.

The great Alcan route, as it is sometimes called, was built and is controlled by the United States Army, and is at the present time open only to military traffic. The project extends from Edmonton, Alberta, 1,600 miles through northern British Columbia and Yukon to Fairbanks, Alaska. At first work moved slowly, but after Pearl Harbour the pace quickened. In early March, 1942, operations began in earnest.

The original Army plans for the Alcan route included three steps for all the unsettled sections. First a very rapid permanent civilian location was to be provided for the whole route by the Public Roads Administration, which is a United States federal road-building organization. Following this location and closely paralleling it, a temporary army road was to be constructed and completed not later than December, 1942. This road was intended to meet military requirements and at the same time function as an access road for the construction of the final road on the civilian location. The final road was then to be built by civilian contractors and upon its completion the military road was to be abandoned.

Unfortunately this schedule could not be carried out because the Public Roads Administration was unable to provide final location rapidly enough to keep in advance of army road construction, and also because it was found that as the road lengthened, the quantity of supplies required to keep construction at peak rate could only be hauled over a road of about the same type as the final road was designed to be. The initial scheme was therefore abandoned early in August, 1942, and the temporary military road became the permanent Alaska Highway.

Laying out a road by air consists of photographing the land, applying a stereoscope and drawing lines on the print. The photograph shows trees and lakes. Jackpine were selected on the Alcan route because they meant a hard dry soil suitable for a good road bed. The curve of the road was established from the position of lakes and rivers. The stereoscope revealed the presence of hills and valleys to be avoided. The lines were then plotted directly on the picture which was forthwith handed to the road crew, who hiked off into the bush and proceeded to build the road on that scanty information.

The road is in good condition now, during the winter months of 1942-43. A loaded truck can do 275 miles in 15 to 20 hours. There is bound to be trouble in the spring, though, as the bridges are only temporary and will go out with the spring floods, holding up transportation for a few

weeks. At the time the road went through it was in no condition to carry steel, even if there had not been a national shortage of that commodity.

A great future is in store for the territory the road serves. The land in the Southern Section is quite fertile, well suited for lumbering, and provides excellent grazing for cattle. The Peace River District will be in a position to market more of its fine grain crops. After the war tourists will make extensive use of the road, for Alaska is a country many Americans will wish to see, and they will use this road as a ready route to that end.

"Storage Reservoirs of Light"

SAMUEL G. HIBBEN, E.E.

Director of Applied Lighting, Westinghouse Electric and Manufacturing Company, Bloomfield, N.J.

February 27th, 1943.

Under the stress of war, long known phosphorescent and fluorescent materials are being developed to a degree which will seriously enhance their possible uses in the world of tomorrow. Commercial and military possibilities of the new materials are still being explored.

Fluorescence is, by definition, a property of certain substances on account of which incident rays of invisible ultra-violet light are transformed into light visible to the eye. Fluorescence lasts only while the exciting energy source of ultra-violet "black light" or some similar activating agent, is played upon the material.

Phosphorescence, on the other hand, is something else again. It is literally "cold light" coming out of storage, and thus continues after the activating agent has been removed. Certain materials have a faculty of storing up a measure of the light to which they are exposed, for release in darkness. The most familiar was long the rotten stump in the swamp. But today, with the incentive of blackouts, we have come a good way from the stump and are going places fast. Present uses of phosphorescent materials are manifold and multiplying under the necessities of war.

For example, phosphorescent materials may be incorporated into plaster walls, doorknobs, fire extinguishers, tools, and other instruments. In dock areas, where wartime precautions make even a dim light undesirable, luminescent materials make possible the marking of danger spots which would otherwise constitute a serious accident hazard in the event of total blackout. Fire extinguishers, first-aid kits, safety belts for workers, and other objects which must be readily distinguishable in event of blackout are given markings which glow in the dark.

Phosphorescent materials of real use to traffic police have been developed, and following the war one may expect phosphorescent plastics which could be used in constructing the outlying portions of automobiles, with useful effect in reducing the number of road accidents.

Fluorescence is at the present time useful in prospecting, because under invisible rays certain ores respond and can be identified by colour. But that only touches on ever-expanding uses. For one thing, it is going to make life even harder for the professional burglars, for a little fluorescent substance dusted upon the handles of lockers, safety catches or family silver, would provide evidence of guilt guaranteed to stick to the lightest fingers and betray them, when exposed to invisible light, as belonging to the veritable hand of villany.

After the war fluorescent lighting will come into its own. It will prove a much more efficient method of producing light because fluorescent light is "cold light" and thus wasted heat energy which is usually associated with electric light will be eliminated.

"The Excavation of Fort Ste. Marie"

K. E. KIDD, M.A.

Assistant Keeper of the Ethnological Collection in the Royal Ontario Museum of Archaeology, Toronto.

March 6th, 1943.

By 1639 the Jesuit Order had maintained missions amongst the Huron Indians for more than a decade. The fathers labouring in the field had long felt a need for some central place to which they could retire for mutual consultation, rest and solace. Accordingly, in the above year, Ste. Marie was established to fulfill such a purpose, by the field leader of the missionaries, Jean de Brebeuf. It may have been but a single cabin to begin with, and seems to have passed through several phases before reaching the ultimately fortified stage. At any rate, Ste. Marie ranks amongst the very oldest European settlements on this continent and is the oldest in Ontario.

In 1648-49 the Huron Indians were completely destroyed by the Iroquois, although the Residence of Ste. Marie was never itself attacked. The Jesuits, realizing their labours in Huronia were finished, burned it on the 15th of May, 1649, and on the 14th of June following, withdrew to Christian Island. Henceforth, the Fort, as it has come to be called, lay in ruins. It was discovered early in the 19th century, but did not come back into Jesuit hands until they purchased it from the late James Playfair about four years ago.

When the Jesuits acquired it, they desired to rebuild it as it had been in 1649. Since no plan is known to exist, they decided to excavate, in which undertaking the Royal Ontario Museum willingly co-operated. Work began in 1941 and continued in 1942.

The ruins of the Fort, contiguous to the Martyrs' Shrine, are on the quiet river Wye, which flows from Mud Lake into Georgian Bay, about two and a half miles east of Midland. The passage of time had obliterated most of the details; great elms grew on the site, and some of the stones had been carted away for construction.

The customary methods of excavation were employed. The area was surveyed and staked out in five-foot squares, each square given a designation, and then the soil was removed in three inch layers as far as there was evidence of previous disturbance. Specimens were cleaned and stored, showing whence they had come; diagrams of soil markings and the like were carefully made, and numerous photographs taken to show the progress of the work and the evidence discovered.

Most of the site in now uncovered, and the plan is known in major outlines. There are four corner towers or bastions, and along the east and north sides, a low stone wall or curtain. Near the southwest corner is a forge foundation. Two principal buildings lay within the fortifications in such a fashion that their west walls were in line and formed the principal defence in that direction. The larger building was about 30 ft. x 60 ft. and contained two large fireplaces and a large refuse pit. The north building, called because of its smaller size the chapel, had no board flooring, unlike the larger one, and only one fireplace. There was a well at the north end of the compound, inside the curtain. Near the southeast corner of the fortified area was a small storage room or root cellar, of unique construction, built by driving upright stakes into grooved sills. It contained seeds of squash, plums, raspberries, grapes, etc. Unfortunately no evidence remained to show the nature of the wooden superstructures.

Three types of cultural remains were hoped for, and found, (a) European, (b) Indian, and (c) European and Indian. The first included goods of metal, glass, earthenware, wood and bone. Amongst the more important iron objects were axes, a shovel, trowel and hammer, scissors, needle-case, holy water font, knives, files, screws, padlocks and hinges. Some glazed pottery and fragments of glass were found, including a spectacle lens and some Venetian glass. Wood was in the form of structural remains chiefly. (b) The principal Indian material comprised numerous sherds, pipes, a few bone objects such as harpoon heads, and a fragmentary bone ladle of some beauty. (c) A small variety of objects showed both European and Indian influence and were probably the result of Jesuits showing the Hurons how to make things according to European methods. Also of indeterminable origin is most of the bone. When identified it will provide us with information of the food habits of the people of Ste. Marie.

Objects of special religious value included a silver medal cast in honour of the first two Jesuits, Loyola and Francis Xavier; the font mentioned above, and a goodly number of rosary beads.

The two primary objects of the excavation have been achieved to the full extent of the time devoted to them. The major element of the ground plan has been revealed and a body of material obtained for the study, or at least the beginnings of a study, of European and Indian culture in 17th Century Ontario; and one of Canada's greatest national monuments has been safeguarded.,

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"Chemical Importance of Petroleum"

R. K. STRATFORD, B.S.A., M.Sc., D.Sc.

Head of the Technical and Research Department, Imperial Oil Limited, Sarnia.

March 13th, 1943.

A hundred years ago chemists believed a mysterious "vital force" was necessary to form the organic substances they recovered from plants and animals. Simpler substances were made from the complex naturally-made compounds. The reverse process, that is, making the complex from the more simple, was believed forever beyond their power.

About the middle of the nineteenth century, however, chemists proved the vital-force theory to be a myth. This opened the whole field of synthesis with the result that great organic chemical industries today duplicate many compounds made in nature and create many more that have never been isolated from any plant or animal.

Although crude petroleum consists almost entirely of organic chemicals, the utilization of hydrocarbons as a source of basic materials for the synthesis of organic chemicals has been delayed until recent years. While such basic chemicals as benzene, toluene, methyl alcohol, acetone, formaldehyde, etc., were being produced from coal tar and wood, the petroleum industry was concentrating on increasing the volume and quality of petroleum fuels, lubricants and related products. Furthermore, the number and complexity of hydrocarbons in petroleum made the separation of single components with the purity necessary for chemical synthesis an exceedingly difficult task. Today, however, manufacturing processes, fractional distillation and solvent extraction have reached the point where pure gaseous hydrocarbons such as ethylene, propylene and the butylenes and liquid hydrocarbons, such as benzene, toluene and xylene, can be obtained in great quantities. The annual production of the greater part of the estimated 250 million or more gallons of toluene for explosives will be made from petroleum. This indicates the scale by which the production of basis chemicals from petroleum must be measured.

The synthetic chemicals that can be made from petroleum hydrocarbons are legion. Benzene, toluene and xylene are the starting points for hundreds of the dyes, flavours, drugs and explosives which have in a large measure been in the domain of the coal-tar industry. Ethylene, propylene and the butylenes can be built into a great host of synthetic chemicals that find use as solvents, aviation gasoline blending agents, explosives, synthetic rubber polymers, resins, plastics, etc.

Present developments in the manufacture of synthetic chemicals from petroleum and the potentialities of much greater future developments have important economic implications for the petroleum industry and for those industries now concerned in the production of basic organic chemicals and finished chemical products. Basic chemicals from the petroleum industry would compete with those of the coal-tar and similar industries, its synthetic rubbers with that from the East, its plastics with light metals and plywood, its dyes, drugs and explosives with hitherto satisfactory products. Large-scale production of chemicals from petroleum would have far reaching effects on the development of many of the nation's industries.

Nevertheless, petroleum basic chemicals will be available and their economic and industrial value should not be lost or wasted. The problems on the manner and extent to which the petroleum industry should enter the chemical manufacturing field are too great for solution by a single industry, too important for hasty solutions and too involved for other than careful dependence on scientific principles. Whether industry as a whole should be asked to plan for the future on a nation-wide scale is a moot question. One possibility is co-operative planning and research by industrial, university and government scientists on methods of safely absorbing the new products which are bound to flood world markets once war demands cease. Only by forethought now will the chemical importance of petroleum be fully and safely realized in the world of readjustments after the war.

"Problems of the Mineral Resources of Europe"

CHAS. H. BEHRE, B.S., PH.D.

Professor of Economic Geology, Columbia University.

March 20th, 1943.

Since the sudden and precipitate rise of industrialism, the minerals of Europe have proved a potent source of war, and therefore many thinking people are of the opinion that the formation of an international Mineral Materials Committee is a necessary part of any well-functioning long-term peace plan to bring to that tortured continent after the war is over.

European mineral problems are conditioned, like those of other continents, by the fixed pattern of distribution, determined by geological factors which can be recognized and used in foretelling occurrence but cannot be altered in any way. These problems have arisen not only because of the localization of mineral deposits. Progressive industrialization and the growth of population pressure also contribute to the crisis, but almost more important than these are political policies. For example, restrictive stock piling, motivated by the desire to build up wartime reserves, has raised serious problems and should receive careful study in any European peace settlement.

Stock-piling operations can be made to work for peace by stabilizing mining and mineral prices, and negatively by placing limitations on the imports of an aggressor nation through an international court. On the other hand, it serves to encourage war if it supplies an aggressor with the means to wage a war for which he would not otherwise have sufficient raw material.

A postwar international mineral council could serve the cause of peace because members would have an opportunity to recognize mutual interdependence of mineral needs, governing the operation of deposits, regulating cartels, removing customs barriers on raw materials, and would at the same time have an opportunity to develop sanctions which would place a brake on any future war.

One of the typical cases of conflict leading to the present war is that Germany has immense coal reserves while eastern France enjoys great iron deposits in Lorraine. The beds of iron ore which grow deeper as they progress westward through France have always been France's greatest mineral asset. Germany has sought to extend her boundaries westward in order to utilize this iron, in conjunction with the great deposits of German coal, to produce German steel. To feed a war machine Germany must have a prodigious amount of ore. Even today, with all her exploitation, Germany is dependent on iron ore obtained from Sweden and other countries. And one of the reasons for her mad Russian adventure was to obtain control of the iron and manganese ore deposits of the Urals and Ukraine.

Under a carefully planned system of mineral interchange, each country could make a contribution to the general prosperity of Europe, for each country has something of especial value to the European economy. Spain, for example, has much to offer the rest of Europe if social and industrial stability could be established and maintained.

Most conspicuous of all European nations in mineral wealth is Russia, which certainly rivals Canada, the United States, and India, in known resources. For this reason Russia must be taken into account in any world consideration of resources and in any plan for world peace. Russia resembles Canada in that there is a wealth of opportunity for internal expan-

sion and development. After the war, Russia, underpopulated, but able to produce great quantities of goods, will for at least 50 years flood her home markets with consumer goods, feeding and clothing her own people. Only in manganese and oil will she offer any large-scale international competition.

"Canadian Fisheries in Wartime"

D. B. FINN, B.S., M.Sc., Ph.D. (Cantab.),

Deputy Minister of Fisheries, Ottawa, Canada.

March 27th, 1943.

Prior to the war, Canadian fish went to the market offering the best price, but today the market is determined largely by an international rationing scheme directed by a combined food board in Washington. This board arranges for a fair and adequate distribution of fish and fish products to the different allied and neutral nations.

Before the war, fishing was, along with farming, a "depressed" industry. It was full of speculation, yet its great vagaries constituted a challenge. Production was in excess of demand. The impact of war brought on a dislocation which gradually became evident, and since 1941 the tide has turned from abundance to scarcity.

Canada had depended upon world markets for the disposal of 75 per cent of her production. Since the outbreak of war there has been an overwhelming increase in demand, accompanied by an alarming reduction in the number of persons engaged in fishing. The demand for fish was never greater than today. There have been Government subsidies and compensation for loss of gear and boats, with a view to encouraging production.

However, in spite of war conditions, the British Columbia salmon fishing and canning industry has maintained its average catch of 72 million pounds. Two-thirds of the 1941 pack (2,250,000 cases) went to the British food ministry; while this and last year's pack will go wholly to the ministry to supply Britain and the fighting forces. Salmon is an important war food because it is a chief source of concentrated preserved protein which fighting and working men and women so need.

Almost rivalling the salmon industry is the newly-developed herring canning industry. Herring, once a surplus on the European market, has become increasingly important for export. Caught on the Pacific Coast, it is canned in tomato juice and exported. Some 1,300,000 cases have gone to Great Britain; but it should not be thought this new industry will

rival the salmon industry in that respect, since it is in response to an artificial demand brought about by war conditions,

Fishing should be one of the first of Europe's industries to come back after the war. European fisheries have been largely lying fallow for nearly four years now, and the population of fish must be increasing as it did during the last war. When the present war is over there should be plenty of vessels for fishing use and abundant manpower.

The situation will present a problem for Canada. Possibly once again there will be fierce international competition for the fish markets of the world. The technique of today might not do for more competitive times and revisions would be necessary. But there is every hope the industry will be able to stand on its own feet without more assistance than is given other industries.

ELECTED TO HONORARY MEMBERSHIP

in the

ROYAL CANADIAN INSTITUTE

These recommendations were approved by the Council and in accordance with the Constitution of the Royal Canadian Institute the names were presented at the Twentieth Ordinary Meeting, held on March 27th, in Convocation Hall.

Election took place at the Annual Meeting, April 3rd, 1943.

ELI FRANKLIN BURTON, B.A., Ph.D. F.R.S.C.

Eli Franklin Burton, Professor of Physics, Head of the Department of Physics and Director of the McLennan Laboratory, University of Toronto, was born in Green River, Ontario, on February 14th, 1879, son of the late George and the late Eliza (Barclay) Burton.

He was educated at the Toronto Public Schools, Harbord Collegiate Institute, Toronto, and the University of Toronto, graduating in 1901 with honours in mathematics and physics.

Upon graduation, Mr. Burton joined the staff of the University of Toronto acting as a Fellow in Mathematics until 1903 and a Demonstrator in Physics 1902-04. On his being awarded in 1904, the 1851 Exhibition Science Research Scholarship and an Advanced Studentship by Emmanuel College, he proceeded to Cambridge where he worked in the Cavendish Laboratory under J. J. Thomson, graduating B.A. (Cantab) 1906.

He returned to the University in 1906 as Lecturer in Physics and in 1911 was made an Associate Professor obtaining in the same year his Ph.D. degree. He continued in this position until 1923 when he was made a Professor and in 1932 he became Head of the Department of Physics and Director of the McLennan Laboratory.

Professor Burton has carried out extensive researches on the Physical Properties of Colloid Solutions and is a recognized authority on the subject in which he has published numerous papers and a text book now in its third edition. He delivered a course of lectures on the ultramicroscope and the optical properties of colloidal particles in the Mayo Foundation Lecture Series. He has also taken a leading part in many symposia on the subject.

He has carried on extensive researches in the Low Temperature Laboratory in the University on superconductivity and allied problems, being an authority on refrigeration and Vice President of the First International Commission of the International Institute of Refrigeration.

Through his enterprise and energy, there was constructed under his supervision the first electron microscope in Canada—a microscope that is finding great use in medicine, industry and commercial undertakings.

In the first Great War he took an active part in the examination of the natural gases of Canada for the helium content and in the experiments carried on in connection with the separation of helium from natural gases.

After becoming Head of the Physics Department, he took a very active part in establishing the Engineering Physics Course in the University and was instrumental in establishing a special post graduate course in Meteorology leading to the degree of M.A. by which it was possible for the Meteorological Service to obtain men with the fundamental training in mathematics, physics and meteorology. This course was established at a very opportune time as it just preceded the organization of the Trans-Canada Airways and enabled the Meteorological Service to build up a very strong staff in a much shorter time than could otherwise have been done.

To meet the great demands for technically trained men for the armed forces in the present war, Professor Burton was very actice in organizing special courses at the University required for the Army, Navy and the Air Force. He has been adviser on many scientific problems connected with the war and is a Director of Research Enterprises Limited.

Professor Burton has always taken a very active part in the affairs of the Royal Canadian Institute. He was Secretary from 1909-11 and a Member of Council from 1930-38, being President for the year 1931-32, as well as lecturing before the Institute on work in which he was especially interested. He was also very active in the organization of the Library.

Professor Burton was elected a Fellow of the Royal Society of Canada in 1913 and a Fellow of the American Physical Society in 1936. In addition to his many duties in the Physics Department he has found time to act as a member of the Board of Education for Weston, Ontario, from 1914-31 and was for several years Chairman of the Board of Directors of the University Settlement.

On August 22nd, 1906, he married Fannie May Wicher, daughter of Rev. John Woodmore Wicher, has one son, Franklin Wicher Burton, on Active Service with the R.C.A.F., and one daughter, Elizabeth Barclay Burton.

ARTHUR HOLLY COMPTON, B.S., A.M., Ph.D., Sc.D.

Arthur Holly Compton at the present time Professor of Physics and Head of the Department of Physics in the University of Chicago was born in Wooster, Ohio, September 10th, 1892. After graduating from the College of Wooster as a Bachelor of Science he took graduate work at Princeton University. He has held positions in Departments of Physics at Princeton, Minnesota, and Washington Universities, before going to Chicago in 1923. He was a Guggenheim fellow and special lecturer in the Punjab University, India, in 1926-27, has been honoured by being granted the Rumford Gold Medal of the American Academy in 1927 and the Nobel Prize in the same year.

Professor Compton is one of two brothers who have made enviable reputations in the field of physics. Karl Taylor Compton, President of the Massachusetts Institute of Technology is an older brother. Professor Compton is one of the few people who have had the honour of having an "effect" named after him. Every physicist knows the Compton Effect. Through Professor Compton's work in the early twenties on the relation between X-rays and other forms of radiation has laid the foundation for the modern conception as to the inter-relation of matter and light. It is interesting to point out that seven Nobel Prizes have been awarded to physicists working in the field of X-rays.

Recently Professor Compton has given a great deal of attention to the study of Cosmic Rays. He has carried out his experiments in this field in almost every part of the world and is looked upon as one of the world's greatest authorities on this subject.

These activities have not prevented him from giving a great deal of attention to outside educational movements. He has been associate editor of the Physical Review and on the editorial board of the Review of Modern Physics, has served on committees of the National Research Council of the United States and has been prominent in the American Association for the Advancement of Science.

ANDREW GEORGE LATTA McNAUGHTON, C.B., C.M.G., D.S.O., D.C.L., LL.D., B.Sc., M.Sc.

General McNaughton was born in Moosomin, Saskatchewan, February 25th, 1887, and was educated at Bishop's College School, Lennoxville, and McGill University, Montreal, where he received his Degree of B.Sc., in 1910; M.Sc., 1912; and LL.D., 1920. He afterwards attended Royal Staff College, Camberley, England, and the Imperial Defence College, London, England. In 1937 the Honorary Degree of D.C.L. was bestowed on him by Bishop's University and LL.D. by Queen's University, Kingston, in 1941.

Among his many important activities was that of adviser, Canadian Delegation to Imperial Conference, London, England, in 1930, as well as at the Conference for Limitation of Armaments, Geneva, Switzerland in 1932; Member of Committee, Trans-Atlantic Air Service, Imperial Economic Conference at Ottawa in 1932; Chairman, National Research Council Associate Committee on Survey Research, and Inter-departmental Committee on Trans-Canada Airway.

In June, 1935, General McNaughton was appointed President of the National Research Council of Canada, in which position he proved himself a scientist of great ability and versatility. In 1939, he was seconded from this position for service overseas.

His military record is outstanding. He served throughout the first great war in the Canadian Artillery. He received rapid promotion, from that of Major, commanding a Battery in 1914, to Lieut.-Colonel commanding an Artillery Brigade in 1916, and to Brigadier-General in 1918, commanding Canadian Corps Heavy Artillery Brigade. He distinguished himself in counter battery work and was awarded the D.S.O. in 1917, C.M.G. in 1917, and C.B. in 1935. On his return to Canada in 1919 he continued to serve as a Permanent Force Officer, filling the following appointments: Member of the Committee for re-organization Canadian Militia, 1919; Director, Military Training and Staff Duties, 1920; Deputy Chief of General Staff, 1923; District Officer Commanding Military District No. 11, Victoria, B.C., 1928; promoted to the rank of Major-General, 1929; Chief of General Staff, Canada, 1929-1935.

In 1939 he was appointed to command the 1st Canadian Division, and was promoted to the rank of Lieut.-General in 1940 in command of a British Corps. In December 1940, he was given command of the Canadian Corps, and in January, 1943, was appointed to command the Canadian Army Overseas.

He is the author of a number of papers, principally published in the Canadian Defence Quarterly.

As a scientist, an electrical engineer, and a keen mechanician he has done much to see that the vehicles, arms, and equipment of the Canadian Army Overseas are second to none, while as a strategist and leader of men he enjoys an enviable reputation.

ROBERT BOYD THOMSON, B.A., F.R.S.C.

In conferring Honourary Membership in the Royal Canadian Institute on Professor Robert Boyd Thomson, we honour one of the most illustrious of our scientific members and recognize his long-continued and devoted services to the Institute.

Professor Thomson's professional career has been centred in the Department of Botany of the University of Toronto, which he has served with distinction for almost 40 years and of which he is now Professor Emeritus. Under his aggressive and far-sighted leadership our botanical laboratories were housed in their present enviable quarters and came to occupy a position of prestige among the botanical institutions of the world. His personal contributions have dealt largely with Plant Anatomy and Phylogeny and these have been a potent influence on botanical theory.

His earlier researches on the anatomy and phylogeny of the Gymnosperms gave him an international reputation, and the later papers of this series, published under his own name and the names of his students, have consistently added to his prestige. He is ranked, by those competent to judge, among the highest authorities in this field.

His studies on the evolution of the seed habit have extended throughout the plant kingdom, and have given us an entirely new insight into a problem that is fundamental in all considerations of phylogeny in the higher plants.

An anatomical and developmental investigation of the true nature of branching in vascular plants has not proceeded as far as the other two projects. It has, however, already been productive of a number of papers, and again the characteristic stamp of Professor Thomson's work is evident, in that an original point of view is opened up, making possible, perhaps for the first time, a reasonable appreciation of the fundamental unity of structure in forms that have seemed diverse and different.

Among Professor Thomson's greatest contributions should be included the inspiration and direction he has given to the successive groups of research students who have been attracted to his laboratories. Through them his influence has been extended to many institutions of learning and research in both hemispheres.

Throughout this busy career Professor Thomson has given generously of his time and talent to the Royal Canadian Insitute which has always remained very dear to his heart. He has been a member for more than 35 years and a life member since 1919. During at least 15 of these years he served on the Council and in 1928 he was elected its President.

In earlier days Institute audiences were among the first to be informed of his scientific discoveries, and to-day he is still to be counted among the most loyal and devoted of the Institute's friends.

JOSEPH BURR TYRRELL, B.A., B.Sc., M.A. LL.D.

Joseph Burr Tyrrell—geologist, explorer, historian, consulting engineer, financier, agriculturist, and mining executive—has enjoyed a greater variety of experiences than most men, in 84 years of life. Graduating from the University of Toronto and Victoria University, he planned on a legal career, but for reasons of health forsook the legal profession for the outdoor life of the geologist. From 1881 until 1898 he served the Geological Survey of Canada and left a unique record of exploration. In association with his brother, J. W. Tyrrell, he made two trips across the Barren Lands. The first was made in 1893 from Athabaska Lake to Chesterfield Inlet, covering a total distance of 3,200 miles of which about half was through territory not previously explored. Overtaken by winter, Dr. Tyrrell walked 600 miles on snowshoes from Churchill to Lake Winnipeg.

The following year he crossed the Barren Lands again, coming out on Hudson Bay, about 200 miles south of Chesterfield Inlet, and made the journey in early winter to Churchill on Hudson Bay by canoe. From Churchill, the return journey was made overland. Great hardships and privations were endured on these journeys, and one without indomitable courage and endurance could not have completed them.

In his other work for the Geological Survey, Tyrrell made explorations in northern Manitoba, in Saskatchewan and Alberta and his reports and maps have been of great value because of his keenness of observation of all kinds of natural phenomena, and his valuable suggestions regarding the potential mineral resources of these new lands. Very little escaped his notice and he has published a number of papers on biological and historical subjects. He is the author of *David Thompson, Explorer,* and he edited a number of works dealing with the early explorations of Thompson, and Samuel Hearne. He has taken a keen interest in the Champlain Society, of which he was president for three years, and he founded the gold medal that bears his name, for achievement in historical studies, in Section II of the Royal Society of Canada.

Dr. Tyrrell received the Back Award from the Royal Geographical Society, the Murchison Medal from the Geological Society of London, the Daly Gold Medal of the American Geographical Society, and the Flavelle Gold Medal of the Royal Society of Canada, and honorary degrees from Queen's and his Alma Mater. He was president of the Engineering Section of the American Association for the Advancement of Science in 1922, and of Section IV of the Royal Society of Canada in 1915, and he is an Honorary Member of the Canadian Institute of Mining and Metallurgy. He is a member of many Canadian, American, and British scientific, engineering and other societies, including the Explorers' Club of New York.

No statement of Dr. Tyrrell's accomplishments would be complete without reference to his sagacity, and the confidence of his associates, in the development of the Kirkland Lake Gold Mine. Applying geological knowledge, he assumed that the known ore bodies in the Kirkland Lake field should be found at greater depth in the western part of the field, and to him must go most of the credit for opening up ore bodies that have produced over 15 million dollars in gold and their discovery has also led to the extension of the field still farther west. He served as president and managing director of the Kirkland Lake Gold Mining Company and he still holds the office of president.

This Institute owes much to Dr. Tyrrell. He served three years as its president (1910-12), assuming his duties at a time when the Institute was in serious financial difficulties and leaving the office with the organization in a sound condition. He was mainly responsible for the Index to the Transactions, a very valuable publication.

In honouring Dr. Tyrrell this Institute honours a great Canadian, and also itself.

EDMUND MURTON WALKER, B.A., M.B., F.R.S.C.

Edmund Murton Walker, Professor of Invertebrate Zoology, and Head of the Department of Zoology, University of Toronto has occupied a distinguished position in Canadian science for many years. As an entomologist his reputation is world wide.

His eminence in science is attested by the following list of positions he has held:

Assistant Director, Royal Ontario Museum of Zoology, 1918-1931.

Honorary Curator of Invertebrate Zoology, Royal Ontario Museum of Zoology, 1931-

President Section V, Royal Society of Canada, 1936.

President Ontario Entomological Society, 1911.

President Toronto Field Naturalists' Club, 1925-1927.

President Entomological Society of America, 1939.

Fellow of the Entomological Society of London, England.

Dr. Walker is the author of more than 90 scientific papers including two superb monographs on dragonflies, taxonomic and distribution studies of Canadian Orthoptera and Odontata, anatomical studies of Grylloblatta, a primitive insect, which he was the first to describe, and several important contributions in parasitology.

Dr. Walker's eminence in science has not interfered with his interest in the humbler pursuits of the field naturalist and he is ever ready to share his immense knowledge of nature with amateurs and beginners.

As Editor of the Transactions of the Royal Canadian Institute for eighteen years, Dr. Walker has made most valuable contributions to the scientific work and standing of the Institute.

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(2) Associate members are ladies who do not desire full membership. They are admitted in the same way as Ordinary members, the annual fee being two dollars and fifty cents.

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For further information relating to membership or to the activities of the Institute, address letter to

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PROCEEDINGS

OF THE

Royal Canadian Institute

SERIES IIIA | SESSION 1943-1944 | VOLUME IX

This publication is issued with the object of conveying a general idea of what the Royal Canadian Institute endeavours to do, along with a brief outline of what it has done in the past. The publication contains abstracts of the popular scientific lectures given each Saturday Evening in Convocation Hall, University of Toronto, during the 95th Session, 1943-1944.

198 COLLEGE STREET
TORONTO, CANADA

CONTENTS

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of

The Royal Canadian Institute

1944-1945

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(Royal Charter granted November 4th, 1851).	
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ARTHUR R. CLUTE, K.C.	1938-39
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OTTO HOLDEN, B.A.Sc., C.E., D.ENG.	1943-44
E. S. MOORE, M.A., PH.D., F.R.S.C.	1944-

THEN AND NOW

THE Royal Canadian Institute has as its object the promotion of science and the results of scientific research. It attempts to inform and educate the public on important matters of general interest; to stimulate research and to act as a liaison between the scientist and the public.

The Institute was established in 1849 in Toronto, at that time the capital of Upper Canada, by a small group of surveyors, architects, and civil engineers. When incorporated in the Province of Upper Canada in 1851 it was definitely to serve Upper Canada, which, in the enlarged Dominion of Canada, came to be the Province of Ontario. If it had been established after Confederation it is likely that it would have been called the Ontario Institute.

The original members of the Institute were William E. (later Sir William) Logan, John O. Brown, Frederick F. Passmore, Kivas Tully, William Thomas Ridout, and Sandford (later Sir Sandford) Fleming. Of these, Sir Sandford Fleming, the originator and founder of the Institute, was the last survivor.

A story of interest from the pen of Sir Sandford Fleming, a great Canadian and a pioneer in engineering, describes the enthusiasm of the early founders:—On February 8th, 1850, a meeting was held to discuss plans for the newly formed organization. Only two members attended, F. F. Passmore and Sandford Fleming. The prospects of the young Institute were not brilliant, but the two determined to act with energy, if not with entire regularity. After much silence and long waiting in vain for other members to appear, the one addressed the other in these words: "This looks bad—we must, however, proceed, as the saying is, to make a spoon or spoil the horn. Let one of us take the chair and the other act as secretary," and so agreed, dispensing in the emergency with a quorum, they passed a series of resolutions with complete unanimity. No amendments were offered and time was not spent in long discussions; those present deemed it a dispensable formality to have "movers" and "seconders" to the motions submitted. As appears by the minute book the meeting simply "resolved" this or that. One resolution adopted and formally placed on record, reads: "Resolved, That the members of the Canadian Institute do after this date meet once a week, on each Saturday at 7 o'clock p.m., in the Hall of the Mechanics' Institute. The first meeting to take place on Saturday next, February 16th, 1850." No fault was ever found with the action taken on that occasion and meetings have been held without interruption since that date.

At the earlier meetings, papers on scientific problems of the day were read and discussed and laboratory work was carried on by the various sections which were established under the administration of

the Institute. The most important of these were the Biological Section, the Geological and Mining Section, and the Historical Section.

The early publications of the Institute, beginning with the year 1851, were also of great value because they were the only ones of their kind in the scientific field in Canada. The first of these publications, "The Canadian Journal: a Repertory of Industry, Science, and Art," was edited by Henry Youle Hind, who conducted explorations in western Canada, and there followed the well-known series on "Toronto of Old" by the Rev. Henry Scadding, D.D., who was President of the Institute from 1870 to 1876.

When the Canadian Institute moved from its building at the corner of Richmond and Berti Streets in Toronto in 1905 to become more closely associated with the University of Toronto it began to establish a more direct communication with the public. On April 2nd, 1914, His Majesty the King granted permission to the title "Royal" and it became the Royal Canadian Institute.

In aiding the public to appreciate and understand the value of research, the Institute has had an important influence in increasing research facilities in Canada. During the First World War the Royal Canadian Institute established a Bureau of Scientific and Industrial Research to promote closer co-operation between science and industry in the prosecution of the war. As a result of publicity given to the value of enlisting scientific aid in the war effort, the federal government appointed an Honorary Advisory Council on Scientific and Industrial Research which later developed into the National Research Council with extensive laboratories in Ottawa. Public realization of the value of science after the war led to the establishment of the Ontario Research Foundation and to increased grants for research in the universities.

During the last few years the Institute has been playing an important part in the promotion of the conservation of our natural resources. It co-operated in the formation of the Guelph Conference organized to study these problems and make representations to the Provincial Government.

Scientific research was never more necessary than it is to-day and will be even more important after the war; in enabling us to develop the resources of our country so that they will yield the greatest possible return. The public should be enlightened on the applications of science to modern problems.

The contributions of science to our material welfare are, however, only a part of its significance to mankind. Probably even more important is its general educational value. It opens to us a broader vision of the world, developing more accurate habits of thought, and thus leading to a greater enrichment and enjoyment of life. For these reasons the educational work of the Royal Canadian Institute is one of the most valuable of its activities.

Some of the Outstanding Accomplishments of the Royal Canadian Institute

1. **Co-operation in promoting the meetings in Toronto of the following scientific societies:**
   (a) The American Association for the Advancement of Science, 1889 and 1921.
   (b) The British Association for the Advancement of Science, 1897 and 1924.
   (c) The International Geological Congress, 1913.
   (d) The International Mathematical Congress, 1924.

2. **Standard Time.**

In 1878 Sir Sandford Fleming brought forward the plan of adopting for the whole earth twenty-four standard meridians, fifteen degrees apart in longitude. He published many papers on this subject, and with the co-operation of the Institute, the zone system of time-reckoning was adopted in most of the countries of the world.

3. **The Museum.**

The Ontario Archaeological Museum was begun under the auspices of the Institute, and continued under its management for six years before being transferred to the Ontario Government and the University of Toronto.

4. **The Ontario Good Roads Association.**

The Ontario Good Roads Association was organized as the outcome of a meeting called by the Canadian Institute in 1894.

5. **Publications.**

The Publications of the Institute have appeared in four principal series and one minor series as follows:—

(1) "The Canadian Journal: a Repertory of Industry, Science, and Art," and a Record of the Proceedings of the Canadian Institute. 3 vols., 4to. Begun August, 1852, ended December, 1855.

(2) "The Canadian Journal of Science, Literature, and History." 15 vols., 8vo. Begun January, 1856, ended January, 1878.

(3) "Proceedings of the Canadian Institute." 7 vols. Begun 1879, ended April, 1890.

(4) The Archaeological Reports of the Canadian Institute were published as part of the Appendix to the Report of the Minister of Education for the Province of Ontario, 1886-1894.

(5) Minor Series. "Proceedings of the Canadian Institute." From 1897 to 1904, two volumes of this series, containing short papers, were published.

(6) "Transactions of the Royal Canadian Institute." Begun October, 1890, and up to October, 1943, Part 2 of the twenty-fourth volume has been published. This publication contains scientific papers on technical subjects, relating to all branches of science. These papers are submitted by those doing research work. The publication is sent to learned societies throughout the world, and these societies send their own publications in exchange. Any Ordinary member of the Royal Canadian Institute may receive a copy of this publication upon request.

(7) "Proceedings of the Royal Canadian Institute." Series IIIA. Abstracts of the lectures given during the year. Begun 1936 and to date nine volumes have been published.

(8) General Index to Publications, 1852-1912. Compiled and edited by Dr. John Patterson. Dr. J. B. Tyrrell, President of the Institute, 1910-1913, undertook to finance the compilation of the index, and made it possible for the Council to proceed with the work.

6. The Library.

As a result of the exchange of publications with learned societies for the past ninety-five years, the Institute has built up a most important scientific library of over thirty-two thousand volumes, many of which are indispensable to scientific workers in this part of Canada. For protection against fire, this library is housed in a section of the library of the University of Toronto, and may be used by the staff and students of the University as well as by members of the Institute.

7. The National Research Council and the Ontario Research Foundation.

It was in large part due to the vigorous campaign of the Institute on behalf of a wider application of science to industry in Canada, that the Honorary Advisory Council for Scientific and Industrial Research, the forerunner of the National Research Council, was appointed by the Dominion Government, and that the Ontario Research Foundation was instituted through the co-operation of the Ontario Provincial Government and manufacturers.

8. University Grant.

The Institute also strongly supported the successful application to the Provincial Legislature for an annual grant for research in the University of Toronto.

Report of the President

1943-1944

As presented to the 95th Annual Meeting, Saturday, April 15th, 1944, held in the Royal Ontario Museum.

The ninety-fifth session of the Royal Canadian Institute draws to a close in the fifth year of war. During the year the situation on the war fronts has materially improved. We look forward with confidence to a victorious outcome with, however, a full realization of the sacrifices and tremendous efforts that must be made to accomplish this end. Much thought is now being directed toward the improvement and stabilization of conditions in the future era of peace. It is generally accepted that the benefits to be derived from recent developments in the field of science will play an important part in this period, as they are now doing in the prosecution of the war. Throughout the life of the Institute, embracing almost a century, one of its main objectives has been to make known to the public advances in science and their applications. It is apparent therefore that at this time this phase of the Institute's activities is a most important one.

The nineteen Saturday evening lectures given during the year have covered a wide range of interests but considerable emphasis was placed on subjects related directly to the war and to conservation and post-war developments.

The lecturers have come from Government departments, universities, research laboratories, the Navy, Army and Air Force, and engineering and industrial organizations, both in the United States and Canada, and have, in all cases, come without honorarium. The attendance has been most gratifying and the subjects dealt with in a manner most appropriate to the general nature of the audiences.

The public address system in use during the year has, we believe, added greatly to the comfort and interest of our audiences.

The enjoyment of our Saturday evening lectures has been fittingly augmented by the organ music so beautifully rendered by Dr. T. A. Davies, who has given so generously of his time and talent. Appreciation of this feature of our programmes has been expressed by members of our audiences on many occasions.

Advantage has been taken of the opportunity offered by certain lecturers to meet and discuss various matters with university students and others specially interested in the speaker's particular field.

On the occasion of four of the lectures, the Institute had the pleasure of holding joint meetings with various scientific and technical societies,

and had the further privilege during the year of taking a part in the commemoration of the 400th anniversary of the death of Copernicus, and also in the series of meetings marking the 300th anniversary of the discovery of the barometer.

My thanks are tendered to all the members of the Lecture Committee and many others who have given valuable advice and assistance in connection with the lecture programme.

Through the hospitality of many of our members, entertainment has been provided for our lecturers during their stay in the city. This courtesy has been much appreciated by the various speakers.

One of the most important of the Institute's activities is the publication each year of the "Proceedings" and "Transactions." The former of these contains abstracts of lectures, the President's annual report and list of members and is sent to all members and to the exchanges. The volume of "Transactions" contains important scientific papers on Canadian subjects and is sent to numerous scientific bodies throughout the world. Durthe year one further number of each was published.

For the effort and care entailed in the preparation of these publications, the Institute is indebted to Dr. E. M. Walker, our Honorary Editor.

Largely from these publications and their exchange with other societies, the Institute has through the years built up a most important library of over 32,000 volumes which include among their number many of the only copies available in Canada. This library, which contains serial publications dating as far back as 1828, while forming one of the Institute's most important contributions to scientific progress, is at the same time one of the outstanding problems confronting us. As has been reported in previous years, about two-thirds of the volumes are in the University of Toronto Library, a large number in dead storage in the basement of University College, and a smaller number in the Institute's building at 198 College Street.

This arrangement, it is believed, greatly reduces the usefulness of the library and during the year the possibility of improving this condition was given consideration at special joint meetings of the Library and General Policy Committees. The report of their deliberations offers alternative plans of procedure. While these will require further study, it is apparent that considerable funds will be necessary to provide satisfactory quarters and services. The provision of these funds offers an unusual opportunity to anyone wishing to render a lasting service to scientific endeavour.

The Institute owes a real debt to its Honorary Librarian, Professor E. Horne Craigie, for the time and attention he has given to the main-

taining of the library in the best condition that existing circumstances will permit.

We have been fortunate in securing recently the services of an experienced librarian, with whose help it is expected the accumulation of publications received can be put into proper condition for binding and improved conditions brought about in the library generally.

The press conferences held each Saturday morning to provide a contact between the press and the lecturers have been continued throughout the year. The press has shown appreciation of this opportunity by the regular attendance of its representatives and they have been most generous in their advance notices and in the reports of the lectures themselves. This has been the cause of considerable satisfaction to your Publicity Committee in view of the wealth of news offering to the newspapers at this time. In addition to the daily press, weekly publications have also given generously of their space. We have been further favoured many times during the year by a review of our lectures over a coast-to-coast radio network.

We wish to take this opportunity of thanking Mrs. Arnold C. Matthews, the Chairman, and other members of the Publicity Committee for the splendid service they have rendered in making possible the dissemination over such a wide field of scientific information presented at the Institute's meetings.

The usefulness of the Institute is dependent on the support it receives, and it is most encouraging to know that so many of the outstanding citizens of this community support its work.

With the welcoming into the Institute of 207 new members during the year, the total membership was brought to the record number of 1607. For this gratifying achievement the Institute is indebted to its Membership Committee under the enthusiastic and able chairmanship of Mr. C. F. Publow supported by the untiring efforts of Mr. George C. Gale.

Various industrial and commercial organizations have continued their support by memberships taken in the name of their employees.

The auditors have placed in the hands of the Honorary Treasurer a signed certificate that they have audited the books and accounts of the Institute and found them in good order. The detailed report of the auditors will gladly be shown by the Honorary Treasurer to any member wishing to inspect it.

The report shows that, for the year ended March 31st, 1944, receipts totalled approximately $9,800 including a Government grant of $500. Expenditures on lectures totalled approximately $1,800, including a new expenditure of $285 covering the cost of the public address system pro-

vided for each of the meetings. The library and publications accounted for $1,600, and administration, building maintenance, office expenditures, etc., totalled $4,500. These expenditures, together with the amount of $1,077 transferred to the library reserve fund to meet expenditures necessarily postponed owing to present conditions, leave a satisfactory balance.

We are again indebted to Mr. C. Watson Sime and Mr. H. Frank Vigeon for having carried out the audit of the Institute's books and accounts.

The Institute in is receipt of advice from the University of Toronto that the space presently occupied by our headquarters will be required to provide the site for additional teaching facilities. This matter has been referred to the Legal Committee who have it under discussion with the University authorities.

With the approach of the hundredth anniversary of the founding of the Institute, which will be celebrated in 1949, a Centennial Committee was appointed to study the form of activities most suitable to commemorate this event. This Committee in its report suggests, among other things, the preparation of a history of the Institute. This proposal is being actively pursued with a view to having this work placed in hand in time to permit of the preparation of a record worthy of the occasion.

During the year the Institute suffered the loss, through death, of nineteen of its members, including a Past President and Honorary Member, Sir Robert A. Falconer; a Past Vice-President, Dr. Harold A. Clark; and a former member of Council, Professor W. H. Martin. The Institute was fortunate in having had their counsel and support and their influence will be felt for many years to come.

In accordance with our electoral system, certain members of Council retire each year. This year we lose from the Council Professor W. B. Dunbar, Mr. T. W. Eadie, Colonel H. J. Lamb and Mr. Wills Maclachlan. Their services have been of great value to the Institute and, while they are retiring from Council, I am sure we can count on their continued support and interest. We extend to them our sincere thanks.

I wish to thank, on your behalf as well as on my own, members and members of the Council who have so willingly assisted in the carrying on of the varied activities of the Institute. I am especially grateful to the former officers whose advice on many occasions was most helpful to one who lacked a full knowledge of the duties devolving on the office of President. To Mrs. C. S. Rawlings, our Acting Secretary-Treasurer, I wish to extend sincere thanks for her unfailing assistance and courteous cooperation.

OTTO HOLDEN,
President.

The Saturday Evening Lectures

One of the objects of the Royal Canadian Institute is to further a popular interest in research. Since the results of research are so far-reaching in their effect upon the life of every member of the community, it is necessary to create an intelligent public who will be able to follow the work and achievements of those who are engaged in it.

What has been done in the past is illustrated by such important accomplishments as the invention of the telephone and the radio, the discovery of radium, the improvement of the telescope, also by the immense access of knowledge as to the structure of matter, whether in the atom or the universe, the manifold phases of life on the earth, and the exploration of the world.

The lectures of the Institute are the medium whereby such work is explained to the public. On Saturday evenings during the season, popular lectures of a scientific nature are given by men outstanding in their own field. The purpose is to interpret scientific research for the public.

"Canada's Water Power"

Its Development and Importance

OTTO HOLDEN, B.A.Sc., C.E.

Chief Hydraulic Engineer of the Hydro-Electric Power Commission of Ontario.

*PRESIDENTIAL ADDRESS.

October 30th, 1943.

The early history of Canada is the story of its rivers. The pioneer highways of the north lands of this continent were not the covered-wagon ways of the Golden West, but the rivers and lakes, the rapids and portages, traversed and overcome by the early explorers and fur traders. The approaches into the northern wilderness that was eventually to become Canada were by way of Hudson's Bay and the St. Lawrence, and thence by the great rivers and lakes that lured men on and for many years afforded the only worth-while arteries of travel, either for commerce or settlement.

Following the opening up of the country by the fur traders came the pioneer settlers. Settlement followed the waterways and, where the pioneers found rapids or falls that could be utilized to lighten the labour of those early days, some enterprising settler, possibly one who had come with capital, constructed a grist or saw-mill, sometimes both, and thus contributed to the development of a small community. Many of these early settlements formed the nucleus of a prosperous town or city. Thus, long before the use of electrical energy, water power played an important part in shaping the development of our country.

But, one by one, these evidences of pioneer enterprise ceased to be profitable and were allowed to fall into disuse. In many cases they were destroyed by fire and little trace remains of what were once active communities.

Within my memory there were on a certain stream little more than a hundred miles to the northeast of Toronto the ruins of two substantial mills, such as I have described. To-day nothing of these remains; but in this case the old order has given place to new, and where the pioneers, with infinite patience and largely from native materials, constructed the grist and saw-mills which faced each other on opposite sides of a beautiful water-fall, there now stand the massive structures of a modern hydro-electric generating plant.

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* Revised by the lecturer.

And so, the once familiar whine of the circular saw and the deeper note of the upper and nether millstones are replaced by the hum of the modern turbo-generator, and the power of the stream is now driving factories a hundred miles away and lightening the labour of housewives in a thousand homes.

Water as a Natural Resource

This evening we are to focus our attention upon the growth and development of water power in Canada, but before doing this I would remind you that the development of power from flowing streams is only one of the many uses to which water, in its larger aspect as a natural resource, may be applied. Many other purposes of great moment are served, such as domestic and municipal supply, agriculture, navigation, and fisheries.

Time will not permit of a detailed discussion of the relative importance of these many uses, nor will we delay even to consider that most important function, the maintenance of the productivity of the soil. Without then in any way derogating from the importance of the other uses of water as a natural resource, it is intended to consider our waterways as sources of power only, covering first their great abundance and wide distribution, and later their development and importance to Canada's progress.

Factors Determining the Possibilities of a Power Site.

At the risk of repeating what may be already well known to many of the audience, and whom I would ask to bear with me, I wish to interject here a simple explanation of the factors that determine the possibilities of a water power.

Power is obtainable when a supply of water can be made to fall, under control, from a higher to a lower level. As you would naturally expect, the greater the difference in the levels, and the larger the flow of water, the greater the power available.

Actually, these factors are in proportional relation. Twice the difference in elevation between the upper level and the lower level—which difference is commonly known as the head—means twice the power with the same flow of water. With double the flow of water and the same head, you also have twice the power. Carrying this a step further means that with twice the head and twice the flow we have four times the power. The head is usually expressed in feet, and for water power the flow is usually given in terms of cubic feet of water per second.

The head may be a natural fall, as at Niagara Falls, or the concentration by a dam of a series of rapids, or a combination of the two. The

flow available, called the run-off, depends primarily upon the size of the drainage area above the power site and upon the precipitation. It also depends upon the nature of the vegetation and the soil, the proportion of lake area, and other factors. These several factors influence not only the total run-off, but also the distribution throughout the year or, as we term it, the regimen of the flow.

In Ecclesiastes we read:

> "All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again."

In these beautiful words the preacher of old expresses the perpetual character of our rivers. The power derived from the falling water in our streams is one of our resources that is continually renewed and is not depleted by use but, with proper protection, may be a permanent asset.

Canada has been generously endowed with water power throughout its great area. The great spaces for catchment of rainfall, and favourable topography, provide a wealth of water power capable of development at economic levels.

Geologists tell us that the most ancient of rocks underly much of Canada; that its topography, size and nature of its waterways and the character of its scenery are in large measure the result of the advance and retreat of the glaciers, which in recent geological times covered much of the country. The topography of the Dominion and its underlying geological formations are vital factors in the determination of its water powers. Their effect on precipitation; formation of lakes and rivers; and on the gradients of these waterways are basic elements of our power resources.

With these considerations in mind, these resources may be grouped in their relation to the main geological divisions:

1. *The Appalachian Area.*

The Appalachian area, comprising generally the maritime provinces and southeastern Quebec, have a general elevation of about 1,000 feet above sea level. It has a rough topography, resulting in rivers with steep gradients and many falls, offering excellent opportunities for the development of power. Owing to the limited size of the drainage areas, the capacities of the sites are relatively small, in spite of a generous precipitation of from 60 inches per annum at the coast to 30 inches in the eastern townships of Quebec. While the aggregate amount of power available in this area, totalling 550,000 horsepower, is not large, it is important in relation to the natural resources of the region—the pulp

from the forests and the famous asbestos mines of the eastern townships of Quebec.

2. *The Precambrian Shield.*

The Precambrian Shield, or as it is sometimes called, the Canadian Shield, includes that part of Canada surrounding Hudson's Bay and extends from the Great Lakes and St. Lawrence River to the Arctic.

In this great area, which embraces about two-thirds of the surface of Canada, there are, as might be expected, great variations in both climate and precipitation, the latter ranging from 10 inches per annum in the northwest to 40 inches per annum in the southeast.

Those of you who have travelled by train along the north shore of Lake Superior or are familiar with the Muskoka country, will have a good idea of the characteristics of most of this great domain. It is, for the most part, a land of rocks and lakes and forests and there is a great deal of it. Modern methods of surveying by aeroplane have added much to our knowledge of this territory and the latest maps show thousands of lakes throughout the area. These lakes, along with the dense forest cover, provide excellent natural regulation of the rivers, thereby adding materially to the value of the power sites.

The waterways within or along the borders of the Precambrian Shield provide about one-half of the known water powers of Canada. In this area are to be found also great forest and mineral resources, the exploitation of which has been made possible by the abundant supplies of water powers available.

Pulp and paper mining, however, do not require all the power available in this district, and many great water powers have been developed to supply special industries. For example, in Quebec, plants for the production of aluminum have been established because of the facility with which large amounts of power can be supplied at tidewater where the necessary raw materials, in this case bauxite, can be brought in by low-cost ocean transport.

As practically all of this area is less than two thousand feet above sea level, the power developments are generally of the low-head type, deriving their capacity from the use of the large regular flows through relatively low heads or falls, in most cases of the order of 15 feet to 100 feet, with an occasional high head, usually on a limited drainage area.

3. *The St. Lawrence Lowlands.*

The next division is known as the St. Lawrence Lowlands. Compared with the total area of Canada, or even of the larger provinces,

this is a relatively small section, comprising about 35,000 square miles. As is indicated by the title of this division, the St. Lawrence River and the Great Lakes which it drains, occupy a dominant place in the waterways of the area.

In this section of Canada is concentrated a large portion of the population of the Dominion, the two largest cities, the great industrial areas of both Ontario and Quebec, and some of the best agricultural lands of these two provinces. Of particular value, therefore, are the immense water powers available on the St. Lawrence and Niagara rivers. On the St. Lawrence River there is a potential capacity of about 5,000,000 horsepower divided between the United States and Canada roughly in the proportion of 4: 1. The area as a whole has a potential capacity of nearly 7,000,000 horsepower.

The Great Lakes and St. Lawrence River, by affording low-cost water transportation and power in large volume, offer opportunity for industrial and commercial development equalled by few districts in the world.

4. *The Great Plains.*

The Great Plains or Prairies, as will be seen on a map of the Dominion, comprise the area lying between the Canadian Shield and the Rocky Mountains. The streams found in the Prairies themselves offer little opportunity for power development. They flow with gradual slopes and with few rapids or falls in channels cut through the plains. Precipitation is light and this, in combination with the nature of the ground surface, results in an extremely low run-off, being only a fraction of that obtaining in eastern Quebec and the Maritimes.

The main water-power resources available for the Prairies are situated in the areas along its borders. On the rivers passing through the northern portions, such as the Athabasca and Slave rivers, there are extensive rapids which may be developed to supply considerable blocks of power.

5. *The Cordilleran Area.*

Finally we come to the great mountainous area between the plains and the Pacific which the geologists call the North American cordillera. The great variety in the topography in this mountainous region makes it difficult to compress into any brief description an adequate picture of its water-power resources.

The main topographic features of the cordilleran area are a western and eastern series of mountain ranges separated by the great central plateaus. In keeping with the topography, there are corresponding cli-

matic contrasts. Great variations occur in the precipitation. The western belt experiences heavy precipitation, owing in part to the effect of the warm Japan current. In the higher altitudes, this exceeds 100 inches per annum and provides a high rate of run-off. This run-off, in combination with the numerous high heads and cataracts on the swift short rivers, afford many opportunities for power development.

In the plateau area, the run-off is considerably less, but many lower head developments are possible in the streams connecting the long narrow lakes found in this region.

On the eastern slopes of the Rocky Mountains most of the important rivers flowing through the prairies take their rise. Excellent opportunities for power development are to be found as these streams descend to the level of the plains and one of these, viz., the Bow River, is already highly developed, and provides power for transmission into the adjacent prairie area.

Estimates of the power resources of the cordilleran area place the potential capacity at about 10,000,000 horsepower, but this figure may be materially increased when actual development is undertaken.

In total, the power resources of the Dominion are estimated to be nearly 40,000,000 horsepower. The turbine capacity now installed amounts to approximately 9¼ million horsepower. As the estimate of 40,000,000 horsepower is based upon sites at which the actual drop or head has been measured, or at least carefully estimated, it may be said to represent the minimum water-power possibilities of Canada. Judging by past experience, it can be expected that the installed generating capacity will exceed this figure by 30 per cent and, if this ration is maintained, we can expect an installation of more than 50,000,00 horsepower when the resources included in the above estimate are developed.

From the foregoing, it will be apparent how generously Canada has been endowed with water power. It is not only in the amount of these resources, however, that Nature has been kind, but also in the distribution and location of them with respect to other resources and conditions.

We find that more than half of our water powers are located in the central portion of the Dominion, roughly, in Quebec, Ontario, and eastern Manitoba, in close association with great mineral deposits and vast forest resources, and in which area there are no known coal deposits with the possible exception of the lignite field in the James Bay area.

While the water power of the maritime provinces is small in comparison with the sites in other parts of the Dominion, they are supplemented by power from an abundant coal supply.

On the Prairies, power is available on the east and west borders from the adjacent areas, while in the districts where the least water power is available there are large fuel resources, and British Columbia, we might say, is doubly blessed with both large water-power resources and extensive coal deposits.

The advantages of this favourable distribution of water power are being more widely realized and appreciated as the development of other natural resources throughout Canada is progressively undertaken, and will be referred to again at a later point. But let us now turn our attention to the development of these great assets and what has been achieved thereby.

Early Use of Water for Power.

In the search for ways of lessening his labours in the pursuit of the means of livelihood, man, since his advent on this planet, has made use of many sources of energy. The taming of animals to carry his burdens probably provided his first assistance.

By virtue of their natural motion, wind and running water must, from earliest times, have been obvious sources of potential power. Along "the great river—the river Euphrates," in the valley of the Nile—cradle of an ancient civilization, and by the mighty rivers of Asia, the forerunners of our present hydraulic plants were devised and constructed by the primitive engineers of that far distant age, to raise water for irrigation and for grinding grain or other purposes.

Float Wheel.

The float or current wheel, probably the earliest form, consists of paddles mounted on a wheel suspended above the river and made to revolve by the current. One of the ancient examples of this type is that known as the Chinese Nora. The wheel itself, constructed of bamboo, was fitted with paddles woven probably of the same material. Many are still to be found operating in the Far East.

Another arrangement used in Byzantium in 225 B.C. for pumping water is considerably more complex. The wheel in this case is placed in a square well-like structure, the water entering and leaving at the bottom on opposite sides. The paddles are turned by the water as it passes through and these turn a shaft which by a crude chain-drive raises the water jars which empty into a trough at a higher level.

A later adaptation was the installation in a Roman grist mill. The water-wheel, by means of wooden cogs, turns the lower millstone, the grain being fed from a trough into a hole located in the centre of the upper millstone.

Some installations of considerable size were constructed, generally for pumping purposes, and among the best known of these was a large installation at London Bridge used to supply water to the city of London about 1580.

From these simple forms, the modern water-power plants have developed and in the course of this development apparatus of many types have been used.

Undershot Water-Wheel.

While serving their purposes, these float wheels were cumbersome and inefficient, and out of them grew the "Undershot" water-wheel in which the water is led by a flume to impinge on blades on the underside of the wheel, where its energy is applied through the impact of its velocity. Sometimes a small fall was utilized, the water reaching the wheel about half way up the lower portion, and commonly called a "breast wheel."

The use of this type of water-wheel was widespread and many adaptations were made, as is well illustrated by an old drawing of a forging shop in Sweden in 1555. Here a series of these water-wheels were used to operate a bellows and to drive a battery of trip hammers.

Overshot Wheel.

An important development in the use of water power was the introduction of the "overshot" wheel. It is this type of wheel which is generally in our thoughts when we sing of "The Old Mill Stream," since it was the type most commonly used for mill operation.

In the overshot wheel the water is brought from a higher elevation in a flume or pipe and delivered on top of the wheel, which is equipped with box-like compartments on its circumference, known as buckets. Through the action of gravity causing the full buckets to descend and empty, and so rotating the wheel, the potential energy of the water is utilized. In this type, the diameter of the wheel was nearly equal to the distance from the flume conveying the water, to the level of the stream below. It is interesting to note that wheels of this type have been known to have efficiencies that compare favourably with modern turbines but, on account of the size of the structures involved, the low speed and other disadvantages, these wheels are not well suited for present day hydro-electric plants.

This type of wheel had a wide application for various purposes and many are still in operation. Indeed, one such installation was constructed in British Columbia as late as 1938 for pumping in connection with a small mining operation. It is constructed very largely of wood, a

material readily available at the site, and probably the main reason for its installation.

One notable example of an overshot wheel that has given many years of service is the great Laxy wheel on the Isle of Man, which is 70 feet in diameter. The water for operating it is brought a considerable distance and, to the best of my knowledge, this development is still in operation.

Turbines.

Improvements and changes in water-wheels were continually brought forward and, after many trials and experiments, largely by practical millwrights, a wheel made of metal and known as a turbine was finally evolved. It is this type of wheel that is used in our modern plants.

In the turbine the water is delivered under pressure around the full circumference of the wheel, which is set in a box or casing. Vanes are provided which direct the water into the curved blades forming the wheel. These wheels may be arranged with their axes vertical or horizontal, as appears best suited to the conditions. The passage ways leading the water to and from the wheel are designed to do so with a minimum of turbulence so that as much as possible of the energy may be turned into useful work.

Early Use of Water Power in America.

In one of the first attempts at colonization on this continent, M. Pontrecourt and his companions in their settlement near Annapolis Royal, in what is now Nova Scotia, found the grinding by hand of grain brought from France a most laborious task, and in 1606 constructed a mill for this purpose on the nearby Lequille River.

This mill was very probably the first water-power installation on this continent. While nothing now remains except some mounds of rock, they mark the site of man's first use in the New World of the power of falling water.

Similar works were later constructed at many points as settlement moved westward. Included in the terms under which seigniories were granted under the French regime was the requirement that the seigneur construct a mill. In some instances, as in the settlement at Detroit,, windmills were provided because of the lack of opportunities in the local streams for constructing water-driven mills. Nevertheless, where favourable sites were found, water-driven mills were constructed. It is recorded that a water-driven saw-mill was built on the Niagara River as early as 1725 to saw lumber for the construction of Fort Niagara.

As the tide of settlement moved westward up the St. Lawrence, many mills for grinding grain were constructed at various points. One

of the earliest in Ontario was erected in 1782 at Cataraqui, seven miles north of Kingston. This mill was constructed by the Government and was followed some four years later by another Government mill at Napanee. These ventures are of particular interest because they mark the early entry of the Government into the water-power field in what is now Ontario.

The history of this period reveals the very interesting fact that the cost per horsepower of constructing these mills was very similar to the cost of constructing a modern hydro-electric plant. The account of the expenses incurred for the construction of one of these mills contains a considerable number of very interesting entries, for a somewhat unusual construction material, namely rum, which is recorded as purchased for the "raising bees" and for the men working in the water at the dam. Modern construction practice is to provide water-proof clothing for water work and to reserve liquid stimulants for such contingencies as snake and rabbit bites, a remedy well known to all anglers and hunters here, I know.

In the years following, many mills, both for grinding grain and sawing lumber, were constructed, mostly by private individuals. By 1850 there were 36 mills on the Ganaraska River alone, almost 2,000 in Upper Canada, and nearly 1,600 in Lower Canada.

In addition to the 3,600 or more water-driven mills in Upper and Lower Canada in 1851, as already mentioned, there were over 200 mills driven by steam engines, mostly saw-mills. At about this time, the turbine, which was previously described, began to replace the earlier types of mill-wheels.

When the dynamo or electric generator was invented, it became evident that the turbine was well adapted for the driving of these generators, and the combination of a turbine-driven generator became the accepted practice.

While hydro-electric units had been in use in Europe and the United States, the earliest utilization in Canada is reported to have been at Young's saw-mill at Ottawa in 1882.

In these early hydro-electric installations, the power generated was used largely for lighting, first in the mills themselves, and soon in the adjacent buildings, but the transmission of electric power was limited to distances of a mile or so.

In 1894, following closely on experimental installations in Europe, power was transmitted from Montmorency Falls to Quebec City, a distance of seven miles.

After the development of the transformer, the transmission of power some eighteen miles to Three Rivers, Quebec, from a newly constructed

hydro-electric development, gave Canada, in 1897, her first long distance transmission, an event which marked the real beginning of the development of our water-power resources.

With the increase in distances to which power could be transmitted, it was no longer necessary for industries to be located in close proximity to the falls or rapids. With the latitude of location offered by the removal of the former limit of distance, factories could now locate at points where other factors, such as labour supply or raw materials, might prove more advantageous. Sites with capacities much greater than necessary for any one industry could now be developed for several, and for distribution to many small users.

In the years immediately following this most important advance, Montreal, Hamilton, and other cities as far west as Victoria, availed themselves of this new source of power, and by the end of the century installations had reached a total of over 150,000 horsepower.

Since the turn of the century the development of water powers has made continuous progress. In the first ten years, over 800,000 horsepower was added in plants located across the breadth of the Dominion.

This relatively new source of energy was in a large measure responsible for Canada's ability to produce munitions in such important quantities for the First World War.

While the rate of expansion was retarded during and for a period after hostilities, the increased tempo of business and the general expansion of industry in the decade from 1920 to 1930 was reflected in the still greater additions made to Canada's power supply. Over three and a half million horsepower was added during this period, in such notable undertakings as the Queenston development in Ontario and the Isle Maligne plant on the Saguenay River. The field of operations was still further extended to the Churchill River in northern Saskatchewan, while in British Columbia several plants were constructed.

While the economic situation prevailing after 1930 brought about a reduction in the demand for power, there was an important gain in installed capacity in developments which were under construction before the business recession. These included many large undertakings, among which were the Beauharnois development in Quebec, the Abitibi Canyon in Ontario, and the Seven Sisters development on the Winnipeg River in Manitoba.

With the outbreak of hostilities in 1939, the rapid increase in demand for power consequent on the large scale production of munitions again stimulated power development in all parts of the Dominion.

The outstanding achievement in point of capacity was the construction of the Shipshaw development on the Saguenay River, where twelve units with a capacity of 100,000 horsepower each have been installed to supply the power needed for an ever-increasing demand for aluminum.

This steady growth throughout the years from the beginning of the century has given Canada an installed capacity to-day of over nine and one quarter million horsepower. It has furnished the energy essential for the economic utilization of other natural resources and has enabled Canadian products to attain prominence in world trade.

As examples of the part our water power has played in the exploitation of other resources, two industries may be cited, viz., pulp and paper, and mining.

Pulp and paper is one of Canada's most important industries in point of view of the capital invested, salaries paid, and in net value of product, and also on account of its influence on our foreign exchange position. In 1941 newsprint made up over three-quarters of the total tonnage of paper manufactured, and of this amount over 90 per cent was exported. The daily average production was approximately 11,500 tons. As each ton of daily capacity requires about 100 horsepower, it is readily appreciated how essential an ample supply of power is to this industry. Of the power used in the manufacture of pulp and paper, 95 per cent is obtained from water.

The prominence attained by Canada's mining industry is so well known that it requires only to be mentioned, but as evidence of its importance to our economy, attention may be drawn to the value of our mineral production, which during 1942 reached the substantial sum, even in these times, of $564,000,000.

Although a variety of minerals is mined in Canada, metal mining is predominant. Practically all of this metallic mining is located in the two great regions which contain the bulk of our water-power resources; i.e., in British Columbia and in the Precambrian area. The former of these regions also contains extensive coal deposits, yet in the mining of both metals and the coal itself, hydro electricity is used almost exclusively. Similarly, the recovery of metals in the latter region, which is without coal deposits, is accomplished by means of power distributed from the many developments in the area.

In closing, let me say once more that the importance to Canada of her water-power resources does not lie in their abundance alone, great as that is, but also in their distribution and their location with respect to other natural resources and centres of industry.

More than 98 per cent of the electrical energy used in the Dominion today is derived from the power of falling water.

In some forty years the pattern of Canada's life has changed from that with an economy based almost entirely on agricultural pursuits to one in which its industries have attained world-wide recognition. This transformation has, in a large measure, been due to the continuous and extensive development of our water-power resources. It is estimated that at the present time 60 per cent of our population is served with electric power for domestic use and thereby is enabled to enjoy the many conveniences which add to our comfort and well-being. Many thousands of farms throughout the Dominion are now equipped with electrical services, with consequent saving in toil and improvement in living conditions for those engaged in this basic occupation.

When we reflect on what has been achieved, our imaginations cannot help but be fired with the possibilities which the future offers, when it is realized that some 80 per cent of our potential capacity remains undeveloped. But in our exploitation of these invaluable assets it is essential that we have vision and due regard for the maximum benefits that may be obtained and not sacrifice the future for immediate gain. Let us be mindful always of our duty to safeguard these priceless gifts by the preservation of conditions affecting them, so that we may pass them on unimpaired, for the use of future generations of Canadians.

Let us be deeply conscious also of the fact that, great as our achievements may be, our continued enjoyment of their benefits is dependent on Agencies above man's sphere and beyond his power to control.

The raging torrent's rush is stilled,
The mighty river works the will of man.
O'er countless miles his web is flung
From which is drawn the quickening force
That drives our modern age.
All this his mind and hand has wrought
That he may lift to happier plane his daily round,
But hand and mind and heart have toiled in vain,
If God, sends not the rain.

"Music of the Out-of-Doors"

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California Representative of the National Audubon Society.

November 6th, 1943.

Wordsworth says:

> "O cuckoo! Shall I call thee Bird,
> Or but a wandering Voice?"

And Shelley says of the skylark:

> "Thou are unseen, but yet I hear thy shrill delight."

Both admit the eye is subservient to the ear when it comes to bird spotting.

Birds have a pitch range of some six octaves, from approximately two octaves below middle C to the neighbourhood of the highest C on the piano. The lowest C is the pitch of the great blue heron, with his deep cellar-like voice saying "walk, walk!" The highest C is the pitch of the chicadee and the tiny golden-crowned kinglet.

The octave below middle C is the pitch of a Western grouse—the tone of the average man's voice. This may explain why men are often called "grousers." The average woman talks in middle C—so that she makes her voice the centre of everything. It is interesting, but probably irrelevant, that she talks on the horned owl level.

The general run of Canadians is not so keen about the songs of wild birds as, say, the English Romantic poets. Up in our Canadian woods is a wonderful little owl that lilts away on C or D. Yet few people ever bother going out to hear him. This owl—the Saw-whet—has a single long-continued note that he may repeat 50,000 times in one night.

The song of the male bird in spring has a twofold purpose. It is used to assert his squatter's rights to some spot, and also to attract a mate. If one makes an intensive study of the pattern and timbre of some species by the aid of musical notes and an appropriate system of phonetics, in order to imitate a bird call, the best way to test its efficacy in practice is to seek out the male and serenade his mate. If the imitation of the song is adequate, he will fly over toward the singer to assert his property rights against his unseen rival.

It is true that bird's songs often go beyond the simple diatonic and chromatic scales in music, but so do musical instruments, as for example,

when they are tuning up, or in swing music, or when little Johnny is busy practising his violin. The most difficult part in reproducing bird calls which will actually fool the birds is the copying of timbres—that is, the specific tone qualities which distinguish the various species. One must take care to tack in all the overtones, so to speak, as well as the basic tones.

Some of the so-called imitative species have revealed surprising results from experiments. Some, with a good deal of disciplining and inbreeding of good singers, have been taught to sing musical motives or whole melodies.

"Plastics in the War and in the Future"

ALFRED E. BYRNE, B.A.

Manager, Plastics Division, Canadian General Electric Co. Ltd., Toronto.

November 13th, 1943.

The first of the modern plastics was celluloid, developed about 75 years ago. A new era in modern chemistry began. To quote Charles F. Kettering: "For the first time in history man has learned how to make materials with properties he wants instead of suiting his wants to the properties of natural materials." The discoverer, John Wesley Hyatt, printer by trade, chemist-inventor by choice, is today known as the father of plastics.

Plastics are materials which, while being processed, can be squeezed into almost any desired shape and retain that shape. Many materials such as glass, most metals, concrete, and so forth, are plastic or formable under certain conditions. But today when we speak of plastics we mean the modern synthetic organic plastics.

Plastics may be of two types: thermoplastic—which can be softened and formed and then resoftened again with the application of heat, like a candle; or thermosetting, which cannot be resoftened when set. On heating they undergo chemical change, and become infusible. A domestic analogy is a waffle.

Plastics are combinations of two or more of only five of the 92 elements. These are carbon, hydrogen, oxygen, nitrogen, and chlorine—all abundant and all easily obtained, in contrast to the metals, which are usually found in small deposits thousands of feet below the earth in widely

scattered places. Gold is where you find it, whereas the basic constituents of plastics are everywhere.

Plastics are very versatile, as we know from observation. They vary in colour. Some are black, others brown, others partake of the colours of the rainbow, still others are crystal clear.. Some exhibit excellent strength, others are not so strong.

Statistics show that it takes 25 years for a new industry to become established. Plastics are coming of age. We will have, not the Plastic Age, but the Age of Plastics. Plastics have many attractive properties. Their light weight, ease of rapid production in complicated shapes, their eye and touch appeal, give them definite advantage over other materials. On the other hand they have definite limitations and for certain applications metals, wood, and ceramics are better. For example, we may not expect a complete plastic automobile, but certainly more plastics will be used in the interior of the car, and transparent plastics will probably be used as part of the roof.

Plastics will certainly come into their own when applied to interior decoration, for they are pre-eminently attractive, and can be moulded into a thousand and one shapes.

Post-war planners class plastics with electronics and aviation as predominant contributors to a prosperous economy after the cessation of hostilities. The limitless frontiers of matter have been opened to man, and will prove rich and fruitful fields to the scientist.

"Ships of the Royal Canadian Navy"

ENGINEER REAR-ADMIRAL G. L. STEPHENS, C.B.E., R.C.N.

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November 20th, 1943.

The Canadian Government, in the year 1910, purchased two obsolescent cruisers, the *Rainbow* and *Niobe,* from the Royal Navy. These were the first ships of the Royal Canadian Navy. In 1910-11 naval expenditures were $1,790,017; officers and men numbered 704. In 1913-14, just prior to the war, expenditures fell to $597,566, with a total complement of 330 officers and men. In 1920, following a quasi-expansion during the war, operations were again curtailed. In 1939, at the outbreak of war, personnel numbered less than 2,000. Today there are over 70,000 officers and men, and expenditures for 1942-43 were over $200,000,000.

When war was declared in 1939 it was essential to build up the Canadian Navy in a hurry on the most practical lines. Ships were required for convoy duty—ships which could be quickly built, simple to operate, and potent against our main enemy, the submarine. The use of fairly small ships enabled us to enlist the services of the Royal Canadian Naval Volunteer Reserve, plus a smaller number of Royal Canadian Naval Reserves. These, together with the original small number of permanent Royal Canadian Naval personnel, and a number of retired ex-Royal Naval Officers and men form the Royal Canadian Navy of today.

There was a nucleus of six destroyers to begin with. Then three *Prince* class passenger boats were taken over from the C.N.R. and converted to auxiliary cruisers—and they have since acquitted themselves very creditably indeed.

Then came the Corvette—the ship which, plus aircraft, broke the back of the U-boat menace. The original corvette has been much improved. We have the Revised Corvette, and the Frigate (really a faster, heavier corvette).

Several types of minesweeper have been developed—the Bangor; the wooden minesweeper; and the Algerine—which is used for long-range work.

The Fairmiles were developed to guard the channels and estuaries through which pass immense quantities of war goods on their way to the battle fronts of the world. They are sturdy craft, hand-tailored for their task. On the West Coast the Fishermen's Reserve carries out patrol work in sturdy wooden craft which were originally fishing boats built for West Coast conditions.

These ships may be described as the fighting ships of the navy—wherein one may meet the enemy and win honours, decorations, or, perchance, death. But to maintain these ships we must have trawlers, tugs, ammunition barges, and maintenance craft of one kind and another.

There is in addition the "shore establishment"—sometimes called the Stone Frigate. These are found from coast to coast and serve as recruiting and training and administrative centres. On the coasts we have our main naval training establishments where instruction is given in gunnery, signalling, seamanship, and all the multitudinous tasks and trades which go into the making of a fighting ship.

It is the sincere hope of all officers and men of the Royal Canadian Navy that never again will we permit our Navy to slip back into its pre-war condition of mere toleration. Ships have gone down. Many have

given their lives. We have paid the price of Admiralty in blood. It is our prayer that Canada, after the war, will maintain a strong, well-balanced Navy, to protect her shores, and to provide for the security of such as pass upon the sea on their lawful occasions—so that the inhabitants of our Empire may, in peace and quietness, honour and dignity, serve our God.

"Prairie Farm Rehabilitation"

GEORGE SPENCE

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November 27th, 1943.

A sound agricultural policy for the prairie section of Western Canada must recognize the fact that drought periods of several years are interspersed with favourable or wet periods. The Prairie Farm Rehabilitation Act, adopted by the federal house in 1935, and since amended, was the first practical step toward building up a long-term programme and policy.

Authority under the Act is centralized under the Federal Minister of Agriculture, who co-ordinates activity under provincial and municipal authorities. Advisory committees drawn from the financial and business life of the community function under the Act, and agriculture is well represented. Executive responsibility is entrusted to the heads of branches engaged in various activities and care is taken to secure and maintain a staff adequate in number, well equipped with scientific and technical knowledge, and fortified with a background of practical experience.

A noteworthy contribution has been made by the cultural division. An active, intensive effort is made to demonstrate to the man working the soil the best methods which have been developed in Experimental Farms as a result of research and experimentation. He thus gets to know what his problem is, viewed objectively, and what he may do to overcome it. He is a better farmer and a better citizen. Organizations for self-help and associated study and effort are encouraged. Soil drifting, soil research to check deterioration, regrassing, tree planting, shelter-belt work —all those things are given careful and specific attention.

Basic soil surveys to determine the economic use of land have been made on over 100,000,000 acres in the three prairie provinces. Thus any action under the Act is based on a solid scientific foundation. Land utilization work consists mainly in getting blocks of submarginal land perman-

ently out of cultivation by developing such land as community pastures for stockmen and farmers in the locality, and 67 pastures totalling 1,250,000 acres have been completed.

Water conservation is a vital part of the plan. Surface or run-off water is stored by natural or artificial means. Financial assistance is given to individuals on a self-help basis for the construction of dams and the excavation of dugouts. Over 20,000 projects, large and small, have been completed at a cost of $1,850,000, a sum which does not include the contribution made by the farmers. A great deal can be said for these small individual projects. It boils down to one thing: the establishment of permanent homes befitting the worthy stout-hearted pioneers of this generation who by unstinted effort opened up a new land in which they and their children can live in security and contentment while applying themselves to the great enterprise of establishing an enduring agriculture on the broad open face of the Canadian prairies.

Then there are the large projects consisting of dams, reservoirs, canals, and other facilities to store and distribute water. These may be largely for stockwatering purposes, as in Manitoba; or for agricultural practices, as in Saskatchewan. In Alberta, both types are found.

The P.F.R.A. has a post-war programme which will cost $111,000,000—a truly sizeable sum. It sinks into insignificance, however, against the sums already spent on relief, and the returns, in human values, and in dollars and cents, will be beyond estimate.

"Medical Advances in the Present War"

SURGEON CAPTAIN C. H. BEST, M.D., D.Sc., F.R.S., F.R.S.C., F.R.C.P.(C.).

Director, R.C.N. Medical Research Unit, and Banting and Best Department of Medical Research, University of Toronto.

December 4th, 1943.

The two great medical developments of the war are the discovery of penicillin, and the use of serum and plasma as shock treatment and for the loss of blood.

Penicillin may prove the greatest therapeutic agent ever found. The number of diseases susceptible to treatment by penicillin is increasing almost daily. Furthermore, a type of mould similar to that from which penicillin is obtained may be developed, which would be effective against

all types of bacteria. There is a limitless field of research in the blending of various strains of the drug.

The amount of penicillin available for some time will be greatly restricted, because the armed services need it, and because of the lengthy process of production. One must pay tribute to Drs. Phillip Greey, C. C. Lucas, Alice Gray, and S. S. MacDonald for their research on penicillin in Canada, and for their development of the pilot plant process which is now being applied to big scale production under the supervision of workers from the Connaught Laboratories.

The use of serum and plasma is a development since the Battle of France. Then the old system of transfusing whole blood was used. There was delay in transportation, often the blood was too old, and sometimes a fatal delay caused by the necessity to type the blood.

In manufacturing dried blood serum, the corpuscles, cells, and fibrin are removed, leaving only a clear liquid of proteins and water, which is dried by a process of freezing. The dried serum can be used without the necessity of typing, simply by adding water. And it will keep indefinitely. If the volume of liquid in the blood stream is reduced below a minimum, the heart is unable to perform its function of pumping. The quick administration of serum prevents fatalities.

The Canadian blood serum project, under the aegis of the Red Cross, was established in October, 1939. In 1940 there were 5,320 donations of blood. In 1941, 34,347. In 1942, 179,893. And for the first eleven months of 1943, 479,053.

Canadian blood serum was used at Dunkirk and Dieppe. It saved an unknown number of lives during the Blitz. It has been used on convoys to Russia, Tunisia, Malta, India, Sicily, and Italy.

Blood serum may have great importance in the post-war world. It can be used for treating nutritional deficiency, and detailed plans have already been made to provide the starving people of occupied countries with serum. It can also be used at Red Cross outpost hospitals and similar places where adequate blood transfusion equipment or skill is unobtainable.

"Broadcasting in Action"

AUGUSTIN FRIGON, C.E., E.E., D.Sc.

Assistant General Manager of the Canadian Broadcasting Corporation, Montreal.

December 11th, 1943.

The C.B.C. is a public institution. It must provide for the needs and desires of the public. It must educate and inform—and entertain. For example, the Canadian public has the right to expect our networks to carry the best type of United States commercial programmes—because of their sheer entertainment value. Having opened its facilities to American commercials, the C.B.C. is honour bound to offer the same privilege to Canadian advertisers.

Consideration must be given to national responsibilities, especially in time of war. The C. B. C. has fifteen men and four special trucks with Canadian armed forces in Europe, to provide coverage either by cable or by voice, via short wave. The C. B. C. must also endorse and support government projects such as Victory Loan campaigns, recruiting drives, and other national undertakings.

A typical C. B. C. programme has its genesis in the office of the General Supervisor of Programmes, who has conferred with the Management for general instruction and guidance. He calls his staff together and it is decided, say, to produce a certain musical series. A producer is placed in charge. He chooses the programme elements with the assistance of an orchestra leader and possibly a dramatic producer. When the participants have been selected and continuity written, the technical staff is called in for consultation. Then follows a rehearsal period, during which the traffic manager looks after routing the programme to the stations involved. Finally the show goes on—and as soon as it is over, drops into oblivion and everyone starts all over again to prepare for the programme "one week from today."

The technical side of broadcasting is of course exceedingly complicated from the engineering standpoint. Many microphones and special effects are used, and the broadcast operator mixes the sound with taste, diligence, and dexterity. Between the ears of the listener and the vocal chords of the songstress is a transmitting medium of extremely delicate electrical circuits, a maze of wires, many thousands of miles of telephone circuits, possibly 25 or more technicians, all working in co-ordination. It can be readily seen that many things may disrupt this delicate equilibrium, for natural and man-made electrical disturbances are legion and may occur at the most inopportune times. But of this one can be certain— the

C. B. C. will at all times and under all conditions strive to provide the best in personnel and the best in equipment, so that "the show may go on."

The C. B. C. is expanding with the times in response to a very real public need. In 1937 it produced in its own studios 12,022 programmes. In the last twelve months it produced 51,672. In 1937 it had 150 employees. Today it has 800. In 1937 its budget was $2,200,000. This year it is $5,000,000. This year it will distribute $1,000,000 in fees to musicians and artists alone, not including its staff of producers and announcers.

Radio broadcasting is a precocious child, even though today we take it for granted. What the future holds no one dare say—but of this we can be sure: be it frequency modulation or television or what have you, the C. B. C. will play its full share in developing and making available to the people of Canada the best there is to be had.

"Education in the Army"

COLONEL GEORGE G. D. KILPATRICK, D.S.O.

Director of Army Education, Department of National Defence, Ottawa.

January 8th, 1944.

In the early fall of 1939 the Canadian Legion sought and obtained authority to initiate a programme of education for the armed forces. Later it was realized that education's contribution to military training could be given best within the structure of the army and, in the spring of 1943, the Directorate of Army Education was organized with an establishment of 38 officers and 51 non-commissioned officers.

Since then the Directorate and the Legion have acted with the greatest co-operation, but independently, in providing educational services for the army. The Directorate takes as its field subjects related to training, and the Legion provides instruction along the line of the men's academic and vocational interests. Educational officers under the Directorate are stationed at the eleven military districts and the Atlantic and Pacific Commands. The Legion has regions which roughly correspond to the military districts with regional committees of educationists, and provides civil assistants to the educational officers.

For the duration of the war the work of the Directorate will be centered on making the resources of education available for the task of pro-

ducing first-rate fighting men. Between the sounding of "cease fire" and demobilization its efforts will be turned to producing men qualified for citizenship, and this will probably take the form of vocational guidance and training.

A wise introduction to the army can make all the difference between a keen teachable recruit and a sullen and reluctant soldier; therefore the educational work begins at the reception centres. Here explanations are given of what educational opportunities are offered in the army. At disposal centres for those awaiting discharge experts are engaged to lecture on subjects related to rehabilitation and vocational training.

The number of illiterates is a matter of deep concern. But at the three basic training centres for upgrading men of low academic standing to a level where they can take army training gratifying success has been met. The fruits of basic educational training will be seen long after the war in a more intelligent citizenship.

Language study, mathematics, and courses on the causes and progress of the war are among the main educational projects under the Directorate. The language courses include Russian, German, Italian, Spanish, and even Japanese and are designed to equip men for special work in the army or civil life.

In the technical branches of the army, especially, the value of the courses in upgrading men in mathematics is shown. In this connection the establishment of army university courses to provide technically trained instructors, non-commissioned officers, and officers is the first example in Canada of State Bursaries and might well be followed in peacetime in educating able young students for public service.

The courses in the causes and progress of the war are usually conducted by young platoon officers and the main problem has been to get the subject properly taught. Under the auspices of the Canadian Association for Adult Education a demonstration school was sent across Canada and gave three-day demonstrations in the technique of group discussion and teaching methods to officers in each of the military districts.

No detailed programme on education and rehabilitation can be worked out until the government's policy on demobilization is made known. Provision must be made for the academic and vocational aims of all personnel and this covers a field no educational institution has ever attempted. We have to meet a demand for every kind of objective from postgraduate studies to beauty culture for the C.W.A.C. Such a programme would have to be integrated with the rehabilitation plans of the Department of Pensions and National Health, which takes responsibility for the soldiers' welfare at the point of discharge.

The work of the Canadian Legion has been to make available to the armed forces facilities for continuing and adding to their academic and vocational interests through the provision of textbooks, correspondence courses, and classes. In any military district a group of five or more soldiers can form a class for off-duty studies. The Legion finds a teacher either in nearby centres or, as frequently happens, among the soldiers themselves. There are more than 70 subjects in the correspondence courses.

Incidental to the provision of textbooks a work of lasting significance to Canadian education may have been accomplished. Universities are considering accepting the Legion's text books for army study as a basis for matriculation. Previously matriculation was based on different sets of textbooks for each province. This establishes the first standard text for matriculation students throughout Canada.

Reports for November 1943 show the number of classes and students as follows: 171 classes with 3,313 men studying subjects distinctly related to their training; 316 classes with 4,200 men studying general subjects related to their vocational or academic interests; and 9,138 men taking correspondence courses.

Experience with education in the army teaches us lessons in post-war educational problems. The number of illiterates and men of low academic standing indicate the need for adult education in Canada. The democracy we fight to save cannot justify itself nor really function till our people are educated in their duties and responsibilities. Adult education is the chief road to this goal.

"Aviation—Past, Present, and Future"

WING COMMANDER T. R. LOUDON

Professor of Civil Engineering and Aeronautics, and Head of the Department of Civil Engineering, University of Toronto.

January 15th, 1944.

Canadians have a great heritage in the field of aviation. F. W. Baldwin and J. D. MacCurdy, working with Dr. Graham Bell at Baddeck, Nova Scotia, from 1908 onward, were among the first in the world to fly successfully. In the first Great War, it has been variously estimated that from fifty to sixty per cent of the Royal Air Force at the end of that war were Canadians; and when the figures are eventually released for this second

World War, we shall have further cause for pride in our contribution to the Empire's fighting strength in the air.

The fact that we are an air-minded people should never be forgotten. It is the basic reason why we should maintain our own aircraft-designing staffs and insist upon our rights in post-war transport flying. Too much emphasis is laid upon the fact that the present wartime aircraft industry will disappear and leave behind very little opportunity for aeronautical engineers. It should be recognized that although we are now engaged in production work of which at least ninety-five percent will disappear when the war ends, there should be a good nucleus of aircraft industry left and we should insist upon its staying with us and not allow it to be taken to other countries who will then supply us with our needs.

It is often argued that our needs in aircraft will be small in peace time. If we have small ideas this is likely to be true. But there is a good basis for a sound industry. There is no doubt that a considerable air force will be maintained by Canada in the future. In the policing of Europe and other parts of the world we will undoubtedly take our share of responsibility. Why should we not develop our own service aircraft and manufacture them? This will form a background for an industry which can supply the needs of our transport business which admittedly may not be large.

Make no mistake, long distance transport flying is here to stay. The twelve-hour Trans-Atlantic flight is now an every day affair and fares in the future after the war will be below those which were often offered by steamship companies before the present war. It is in this realm of trans-oceanic flight that Canada occupies a strategic position. A glance at the maps will show that many great circle routes from the United States to other foreign countries pass over Canada. There has been much talk on the part of some people about the "freedom of the air." There is no more reason why foreign countries should use our air routes for nothing than that railways should run over Canadian lines free. But the sensible thing to do is to develop our own lines for this long distance traffic. There is an added reason for this in that we in Canada have more knowledge of winter operation than any other peoples in the world. This may seem strange in view of some of the propaganda we often see, but it is a fact nevertheless. This being the case we should design, construct, and operate our own aircraft for use over our northern regions and into similar areas of other countries such as Russia.

The question of the probable future size of aircraft comes up from time to time. There is no limit in size as far as structural design is concerned. In many respects, the larger an aircraft is the easier it becomes to fabricate. The economic traffic requirements will undoubtedly con-

trol the size of aircraft from time to time. At the present time a cruising speed in the neighbourhood of 300 miles per hour seems to be indicated, but again this is a matter of traffic economics. There is no purpose in demanding expensive high speed if it merely results in landing you at your destination at two in the morning when a slower speed would accomplish the same result at the convenient hour of say seven-thirty. High speed in the air has to be paid for just as it is on the luxury sea liners.

Jet propulsion, which is now beginning to appear feasible, may simplify the mechanical complication of the present engine installation. There is a long way to go, however, in this field of investigations before the fuel economy is sufficiently low to compete with that of the present engine power plant in commercial operation.

The helicopter has received a great deal of publicity recently but it is still in the advanced experimental stage, perhaps nearing commercial operation in restricted fields. In Canada, when all the "bugs" have been taken out of it, the helicopter could be used to great advantage for mining prospecting. It could land and take off in small lakes in the north country which are impossible for use with ordinary aircraft. For short distance trips say from an airport to the centre of a city in a few minutes' time there is also undoubtedly a use for this machine. The main useful characteristic of the helicopter is its ability to land on and take off from small areas. It can also be used in bad foggy weather as it can be flown on instruments across country and can hover above its landing field, gradually coming down until the ground can be see from a few feet above. It should be definitely understood, however, that the cost of these machines at present puts it out of the realm of private flying so often picturesquely hinted at in the press.

Private flying in the post-war period will undoubtedly be carried on through some co-operative effort such as flying clubs or commercial organizations. It should never be forgotten that aircraft have to be serviced by very experienced mechanics after every flight. This cannot be left to the haphazard methods used by automobile drivers. Very few private individuals could afford to pay mechanics to look after one aircraft. The result will be that even those who have their own aeroplane will join in some club of co-operative effort whereby a staff of competent mechanics will look after a number of machines thereby lowering maintenance costs.

But there will be a large development in private flying. Thousands of young people have learnt to fly and they will carry on after the war with flying, some for pleasure and others to get about the country faster in the manner to which they have become accustomed.

There is one thing, however, in Canada which we should possess. We have the nucleus of a highly competent aviation research establishment in

the National Research Council. An airport should be provided for this work. There are those who say that we cannot compete with the United States in this respect. This is a false basis of reasoning. We cannot compete with the United States in volume or size but there is no reason why a smaller establishment cannot do as good work as far as quality is concerned. There are many fields of aviation investigation to which Canadians can bring to bear just as highly qualified endeavour as anyone else in the world but it cannot be done without proper flying facilities.

"How to Judge a Book"

CHARLES R. SANDERSON, B.Sc., M.A.

Chief Librarian, Toronto Public Libraries.

January 22nd, 1944.

J. Harvey Robinson has said that some of the greatest contributions to intelligence have been made by novelists. That is a reasonable statement because the raw material of novels of any quality is humanity: the thoughts, actions, loves, and hates of mankind. The gifts or genius of the novelist carry us beyond the narrow horizons set by our own limited human experience.

It is regrettable that so many people are afraid to trust their own judgment of books and, submitting to spoon-fed views, become victims of various cults. For books are not an end in themselves but a means leading to an enlarged perception of life.

In forming a personal judgment of books, as nothing is of value except in relation to something else, there must be a measuring stick. Thus the novel must be viewed in the light of its own heredity and environment. It is necessary to recognize its background and contemporary influences and its place in definite literary movements as well as in the large panorama of literature.

While Jane Austen lived in a period of great events, her writing reflects the environment only of a little circle of characters whose petty egotisms in an atmosphere of comfort and security would bore us to tears in real life. Yet her humour and irony makes them real and entertaining and for that merit her books are read probably more today than in her lifetime. Scott fitted into the mood of his time, describing the great sweep of events on a wide canvas filled with pictures of crowds and armies on the move. Dickens, while oversentimental, brought his char-

acters to life and made them symbols of our own fundamental ideas of humanity.

With Charlotte Bronte, for the first time, the element of personal revolt was introduced into the novel: "Jane Eyre" closely parallels her own life and passionately expresses a feminine point of view for which she was bitterly criticised. In "Wuthering Heights," considered by many the greatest of all Victorian novels, Emily Bronte introduced a new technique, got away from the purely personal and incidental happenings and brought to her work something fundamental and cosmic. This same element of man against fate was further developed by Meredith and Hardy. Stevenson, deliberately rejecting what had gone before, became the greatest of romanticists.

After the turn of the century the English novel was dominated by Bennett, Galsworthy, and Wells. The former two continued in their original vein after the last war, but Wells deflected into works that were mainly fictionized discussions of world events.

Two major literary movements followed the last war, growing out of a stimulated popular interest in eugenics and biology and bitter disillusion. The extreme naturalistic biological novel has somewhat subsided. But the bitter attacks of the 1920's led by such writers as Dreiser, Sinclair Lewis, Faulkner, Hemingway, and Dos Passos, are, in some directions, still continuing.

Other significant modern trends were represented by James Joyce, Virginia Woolf, Dorothy Richardson, and Gertrude Stein. Joyce and Miss Stein were considered unintelligible nonsense by many critics, yet each had an aim. Joyce's style was an effort to bring the subconscious workings of the mind up into the conscious. A parallel might be drawn between the works of these two writers and modern developments in art. Joyce's attempt to interpret the subconscious has been compared to surrealism in painting; and Miss Stein's word patterns to cubism.

"Metal Ceramics"

JOHN WULFF, E.M., M.S., D.Sc.

Massachusetts Institute of Technology, Cambridge, Massachusetts.

January 29th, 1944.

Metal ceramics deals with the making of finely divided metals, their molding into shape, and their firing into articles of use. Molding is accomplished by presses delivering from about 1-100 tons per square inch. Although many articles at the rate of 50-100 per minute have been made in this fashion to save machining costs, the major function of this field, which is more often called powder metallurgy, is to make articles that cannot be made by melting. Examples well known in the production for the war effort are high-speed cutting tools made of tungsten carbide; cutting wheels made of diamonds in a bronze matrix; silica graphite and lead, in bronze and iron sponge structures for bearings, brakes and clutches in airplanes, tanks and other mobile machinery. Metallic filters and oil-less bearings which cannot be made by fusion methods, are easily fabricated by the technique of metal ceramics. The most common application is that of tungsten wire for lamp filaments and electronics equipment of all kinds. Tungsten parts can also be fabricated by powder metallurgy (metal ceramics) methods. Although the art has made rapid strides recently, the techniques used are extremely old. Ample evidence exists that early Egyptian and Indian craftsmen utilized similar methods to make jewelry, steel, and other metallic parts.

Metallic powders used in this process are made by gaseous reduction, by electrolysis and by mechanical devices. After molding into shape the briquettes are heat-treated or sintered to give them additional strength.

In powder metallurgy some metals can be worked which cannot be easily cast owing to their high melting point. One such metal is tungsten. Also by this method some metals can be combined which cannot be melted together to form a homogeneous alloy. When melted together many metals separate in layers somewhat like the ingredients of a salad oil dressing. In metal ceramics through the process of powdering, pressure, and sintering these separate metals can be welded into a solid mass, forming, to continue the figure, a solid emulsion within the mass.

In addition to articles which can be produced only by powder technique, there are a great many other objects previously made from castings by machining that can be more efficiently made by the powder method. Thus, casting impurities and segregations have been avoided, rigid control of composition has been obtained, and in some cases, notably with

precious metals, excessive machining and scrap losses have been eliminated. Magnetic materials, thermostatic and other bimetals, stainless steel and other noncorrosive alloys, and dental alloys are but a few of the many applications.

Limitations on the development of the art of powder metallurgy are imposed in part by the great pressures required in compressing the briquettes into molds. This condition establishes definite dimensions beyond which, at present, it is impossible to go. To obtain parts of high ultimate strength is likewise not always more economic if the powder technique is substituted for customary methods. In each case a thorough analysis of the problem is imperative to determine the most suitable manufacturing technique required.

"How Should We Use Our Canadian Resources?"

ROBERT C. WALLACE, C.M.G., M.A., D.Sc., Ph.D., LL.D., F.G.S., F.R.S.C.

Principal and Vice-Chancellor, Queen's University, Kingston.

February 5th, 1944.

It is a fact of ominous significance that our Canadian natural resources, which should be available for future generations as well as for ourselves, are rapidly deteriorating. This takes on added significance in the light of conditions that will be faced in the post-war years. There are few ways in which men may be more effectively employed than in constructive measures to protect and rehabilitate our natural wealth; nor are there many kinds of occupation that will be better suited to the temperament of some demobilized men than such out-of-door work.

The resources should be looked at as a unit, not as separate assets. In this view the primary importance of the forest is emphasized because other resources—wild life, soil, water level and water power, mining and the tourist industry—are so directly connected with it.

Fifty-eight per cent of the land area of the Canadian provinces is forested. The forest is a protective cover for soil and a regulating agent for the surface flow of rainfall and snowfall into rivers and streams and into the underground water reservoir. Fortunately the natural growth of the forest under Canadian conditions is such that, if properly managed, our forests can replenish themselves by normal growth for the loss by cutting, fire, and parasites.

Plans have been prepared by government departments which provide for roads deep into limits in order that cutting may proceed systematically; regulation of river flow; improvement of fire protection and control of parasites, calling for the employment, for five years after the war, of 75,000 men, many of whom will have to be trained in forestry.

While these are measures of conservation, there are many areas in which planting has to be done. The survey that has been made of the Ganaraska watershed has indicated the steps that must be taken in that area and in similar areas across Canada to restore land that has been deteriorating since the forests were cut down.

In considering the various natural resources as a unit, life in pioneer areas can be made more profitable by combining different activities: farming and forestry; fishing, forestry, and mining. Hence the necessity of regional committees in which the development of all the resources can be considered in a united front. Minerals disappear with development, and cannot be replaced, but soil and forest management may make permanent settlement possible in such areas.

Our water power is a great asset. It should be made available in the form of electricity to our farm homes across Canada. We must give our mineral industry a chance—through remission of taxation—to plan ahead for future development. So little exploration and development has gone on since the war that there may be less, rather than more, employment in mines after the war. An important consideration in fixing mining taxation is that high costs of production make the recovery of low grade ore unprofitable, and if low grade ores are not taken out with the high grade ores their values are lost forever.

Extensive and long continued investigations are needed on our inland fisheries, in order to maintain their commercial value and provide continued attraction for our tourist trade.

Departments of the provincial and Dominion governments are alive to the implications of the rapid deterioration of our resources. But unless they are supported by an alert and well-informed public demand for action, they are unable to accomplish what they wish to do. On every hand we need more knowledge, more and better trained men. Research, pure and applied, is the way that will unlock the door to the treasures which as yet lie undiscovered. We must be generous in assisting the search for knowledge.

"Nutrition in Wartime—What Can We Learn From It?"

L. B. PETT, PH.D., M.D.

Director, Nutrition Services, Department of Pensions and National Health, Ottawa.

February 12th, 1944.

Great Britain is the outstanding example from this war of what can be done in the way of organizing food supplies and a food policy on a national basis for the national good. There, better health has resulted from a food and agricultural policy based on sound scientific principles according to the best available nutritional knowledge. It is a miracle that the nation's health has been even maintained, let alone improved, in the face of unprecedented problems of housing, over-work, and nervous tension. Yet the report of the chief medical officer of Great Britain shows that the over-all death rate and the infant and maternal death rates are down. There have been no serious epidemics.

Lessons can be learned from the experience in Great Britain. While many of the restrictions and controls there have been the result of grim necessity yet the same nutritional principles could be applied in peacetime and in any country, but they never have been applied in peacetime as a national policy by any country in the world.

Three main factors contributed to this success. Britain had the advantage of an accumulation of knowledge of how food consumption levels depended to a considerable extent on income, and to a further extent on ignorance of food values gathered by patient scientific surveys over the last quarter of a century.

In rationing there was an organized nutrition plan to bring food to the people regardless of their food habits or their income, so that all could contribute equally to winning the war. The available food supply was distributed according to the physiological needs of every section of the community. This factor for success was implemented by control of quantities, supplies, distribution, and price. Instead of rationing just on the basis of shortages they rationed to assure a nutritional minimum of foods taken with other food available.

The third factor for success in the food policy of Great Britain has been the determination to see it through and particularly to explain it to the public on every occasion even though this meant spending millions of dollars on information.

In carrying out its policy special feeding services were developed for special groups, including a system of school meals, factory canteens, day nurseries, and communal restaurants, extra rations being provided to adolescent factory workers, to expectant and nursing mothers according to a nutritionally scientific plan.

From the principles so successfully adopted in Great Britain under the stress of war simple deductions can be drawn for a practical nutritional programme on a national scale for Canada and other countries. In a programme for national health adequate food provided on a scientific basis for all people is a fundamental necessity. We have an example showing that it can be done.

"Speeding Stars"

F. S. HOGG, B.A., A.M., Ph.D.

Associate Professor of Astronomy, David Dunlap Observatory, University of Toronto.

February 19th, 1944.

Of the hundred thousand million stars which make up our Milky Way, the radial velocities of less than 10,000 have so far been measured. The David Dunlap Observatory is making a substantial contribution to this field of research. In the last nine years it has determined about 10 per cent of the total of published velocities of stars. Between 90 and 95 per cent of its observing time has been devoted to this purpose. There is no hope of ever measuring the speeds of all the stars in our galaxy and astronomers have for years selected certain samples of the stars for analysis, just as public opinion polls now sense the reactions of the nation by testing the reaction of small samples of the population.

The stars are found to be speeding along at some 15 miles a second on the average. Some stars travel 10 times this rapidly. The radial motion of stars is away or towards us on the line of sight, as distinguished from the transverse motion across the skies. The method of measuring this radial velocity is similar in principle to that of judging the speed of a locomotive from the pitch of its whistle. The frequencies of the light waves shown by the spectroscope are analysed and as they are contracted or spread out relative to the spectroscopic lines of a normal or stationary star, the speed and direction of the star under observation are calculated.

A star with a speed of one mile a second will cause a shift of 1/50,000th of an inch in the spectroscope. These observations then must

be corrected to the movement of the earth around the sun and the solar systems two-hundred-million-mile orbit around the Milky Way.

Looking still farther off into space we find that other galaxies of stars are almost all fleeing from us at apparent speeds up to 25,000 miles each second or nearly 1/7 the speed of light. The interpretation of this recession as an expansion of the universe is now under close scrutiny as one of the fascinating problems in cosmology and philosophy. The most distant nebulae which can now come under observation with the world's largest (100-inch) telescope is apparently five hundred million light years away. The observation of such nebulae requires photographic time exposures of as long as 108 hours.

A ratio has been observed between distance and apparent speed of recession. The speed of recession appears to increase 107 miles per second with each million light years of distance. The completion of the new 200-inch telescope at Mount Palmar, California, may throw unsuspected light on the theory of the expanding universe. It should permit observations twice as far into space as is possible at present or one thousand million light years. If the apparent ratio of acceleration of speed to distance should continue this would raise new and puzzling problems in the theory and observations of astronomy. For it is theoretically impossible for bodies to attain or exceed the speed of light. It could cause speculation as to whether the speed of light slows down in its course through such vast distances of space, whether the known frequency of vibrations might change, or even whether the atoms which caused the light were the same a thousand million years ago as they are understood to be now.

"The Coming Age of Rockets"

G. EDWARD PENDRAY, A.B., M.A., LL.D.

Assistant to the President, Westinghouse Electric and Manufacturing Company; formerly President (now member of Board of Directors) American Rocket Society.

February 26th, 1944.

From the familiar skyrocket, deadly weapons of war and a new source of motive power for aeroplanes are being developed, which probably will usher in a new era affecting military matters, transportation, aviation, and meteorology.

The revival of experimentation with rockets occurred after the last war. It was given impetus by the development of light metals and new

pyrotechnic fuels. Its use was not new in military science. It was employed in the wars against Napoleon and later nearly all armies had rocket brigades. Then it was rendered obsolete by the greater accuracy of the rifled cannon.

In the present war the best known adaptation of the rocket principle is in the American bazooka and the Russian Katiuska. The rocket gun is generally credited with having saved Moscow from the Stuka bombers when it was used as a salvo weapon. The absence of recoil make it effective as a one-man, anti-tank gun.

In principle the propulsion of the rocket is based on Newton's law that for every action there is an equal and opposite reaction. It pushes forward by ejecting gas at high velocity. Its operation does not require an atmosphere to push against; in theory it would work better in a vacuum than in air. In this way its motive power will be effective at great heights and in rarefied atmospheres impossible for other modes of transportation.

The rocket is the most efficient method for transforming chemical energy into mechanical energy; and the development of liquid fuels, by means of which its direction can be more easily controlled, offers the greatest promise for the future.

One of the more immediate post-war uses of the rocket may be as an auxiliary to the aeroplane in assisted take-off; the rocket's power could hoist planes on shorter runways and possibly thus increase the pay-load by 50 per cent. In weather forecasting rockets could carry meteorological instruments 20 miles into the stratosphere and make weather forecasting possible perhaps for as much as two weeks in advance by observations of the upper air currents. Still further altitudes up to 200 miles could probably be reached by rockets equipped with cameras for astronomical and cosmic ray studies.

Longer term speculation has envisaged mail and light express or even passengers being shot across the Atlantic in two or three hours by a combination of rocket and jet-propulsion aeroplane. This would perhaps mean a trajectory of 500 miles above the surface of the earth.

Some of the liquid pyrotechnic fuels used for rocket propulsion, notably liquid oxygen and gasoline, have five to ten times the power of T.N.T.

"The Opening of the New Northwest"

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March 4th, 1944.

An impetus to the development of the northwest was given by the Japanese occupation of Kiska and Attu, which had necessitated the building of the Alaska Highway and of the Canol pipeline from Norman Wells to Whitehorse. Following these projects studies are being made on the northwest, including Alaska, by groups in Canada and the United States, collaborating with each other on what is known as the North Pacific Planning Project.

The Canadian part of this region amounts to more than half of the combined Canada-United States area and includes the Yukon Territory, the Mackenzie District, and the northern parts of British Columbia and Alberta. It covers approximately three quarters of a million square miles. The main objective in the study of the region is to determine what population we may expect it to support, which in turn depends on the question of what industries are likely to be developed in it.

The biggest effort to date in appraisal of resources was made in the summer of 1943 and the results of investigations of several parties are now being analyzed.

Mining has always proved in other parts of Canada to be the spearhead of economic development. In the region under consideration the most notable developments in mining have been in lode gold, pitchblende, oil, placer gold, mercury, copper, silver, tungsten, and coal. A variety of rare minerals was discovered in the Precambrian last summer and throughout the mountains generally there are great areas where prospecting for metallic minerals may be carried on with promise of success. The greatest promise of mineral development lies in oil along the eastern edge of the mountains and on the lower Mackenzie River.

In agriculture the greatest expansion will undoubtedly take place in the Peace River basin, though smaller areas of suitable agricultural land were noted at Fort Nelson, in north central British Columbia, and west of Whitehorse.

The most valuable forest resources are those of the Coast belt. The central interior forests of British Columbia, while having great potential value, must await better transportation facilities. Wild life resources

can be sustained for all time and even greatly expanded, an important consideration not only in the life of the natives but also as an attraction to tourists and sportsmen.

As to population possibilities: In the Precambrian country we may expect centres of population to develop, based upon mineral occurrences, but as these resources are generally erratically distributed, the distribution of population will also be erratic. The section west of the Mackenzie River offers somewhat greater assurance of better distributed and sustained population on account of better soil and climate and, above all, the greatest possibilities of oil development in Canada; the Pacific watershed, owing to an easier climate favorable to growth and definite industrial possibilities, it is reasonable to hope, will support a density of population comparable to that now found in Norway. On the whole it would be somewhat optimistic to look for a great rush of settlement into our far north as seems to be anticipated in some quarters, except as occasioned by mineral discoveries. With respect to temporary population the picture should differ. Few countries have such attractions to offer. Much improvement in the Alaska Highway, which will be handed over to Canada as a military road, will be necessary before it becomes a highway such as tourists have been accustomed to on this continent. But that the northwest will ultimately become a great tourist region there is no doubt.

"Enemies of the Forest—Man or Insects?"*

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March 11th, 1944.

About a hundred and twenty years ago, when Kirby and Spence, two famous British entomologists, published their masterly treatise on insects, they prefaced it with a lengthy apology because "in the minds of most men, the learned as well as the vulgar, the idea of the trifling nature of his pursuit is so strongly associated with that of the diminutive size of its objects, that an entomologist is synonymous with everything futile and childish." According to these same authors, Pliny, Reaumur, Sulzer and others found it necessary to adopt a defensive attitude towards their readers, and "though in this country things are not quite so bad as they were when Lady Glanville's will was attempted to be set aside on the ground of lunacy, evinced by no other act than her fondness for collecting insects,

* This lecture, printed in full, was delivered before the Royal Canadian Institute and was illustrated with Kodachrome slides.

yet nothing less than line upon line can be expected to eradicate the deep-rooted prejudices which prevail on this subject."

In this, our twentieth century, we may perhaps discern some progress on the part of the multitude in that notorious evolution of vulgar parlance through which the old epithet "bugs" is rapidly losing ground to the linguistic, botanical ersatz-term "nuts."

Be that as it may, among the educated the old contempt of the insect world is definitely being replaced by a more or less vague sense of mystery, perhaps, even fear. This attitude is egregiously expressed by Maeterlinck in his "Life of the Bee"; "The insect," he says, "does not belong to our world. The other animals, even the plants, notwithstanding their mute existence and the great secrets which they jealously guard, do not seem wholly strangers to us. In spite of everything we have a certain feeling of terrestrial kinship with them. They may surprise, nay, astonish us, but they fail to upset the very foundations of our concepts. The insect, on the other hand, displays something that seems incongruous with the habits, the morals, the psychology of our globe. Apparently it comes from another planet, more monstrous, more vigorous, more demented, more atrocious, more infernal than ours. Vainly does it seize upon life with an authority and a fecundity unequalled here below; we can not accustom ourselves to the idea that it is part of the scheme of that nature of which we fondly believe ourselves to be the favorite children. With this amazement and this failure to understand is mingled, no doubt, a certain instinctive and profound feeling of dread imparted by these beings so incomparably better armed and equipped than ourselves, these containers as it were of compressed energy and activity which we vaguely feel to be our most mysterious enemies, our final competitors, and perhaps our survivors." That, Ladies and Gentlemen, is poetry, but it contains more than a grain of truth. Among other things, it explains, in part, the choice of the title of this lecture, "Enemies of the Forest—Man or Insects?" In my innermost heart of hearts, I can think of nothing more inept and more absurd than to speak of either man or beast as "enemies of the forest." It is nothing but loose talk, based on an utter misconception of the whole natural order. While etymologically "enmity" is a mere negation of friendship, actually in the minds of men, it carries a very positive connotation of "hatred."

Now I ask you, do men, as a class, "hate" the forest? The answer is: "No." It is true that a few individuals, engaged in special occupations, such as colonization and prospecting, may harbour in their breasts a certain feeling of resentment toward the forest because it is an obstacle to be surmounted. But, they do not represent mankind as a whole. Men either love the forest or they are indifferent to it. Do insects "hate" the forest? Again the answer is: "No." They are too low in the scale of living beings to be truly capable of either love or hatred. It takes brains to hate, that is why man is the supreme master of the art.

Change the words "enemies of the forest" to "destructors of the forest," the picturesque "Waldverderber" of the Germans, and the answer to our question becomes: "Yes," both for man and for insects. More than often, as we shall see later, they become partners in the crime and, as Kipling has it: "For the sin ye do by two and two, ye shall pay for, one by one." The trouble is, that, in the pay-off, man usually gets the worst of the deal.

In the natural order, destruction is the outcome of maladjustment. Although, at first sight, it appears as a negative factor in evolution, it can and does produce positive, constructive results. Our ideas of natural selection and of the balance of nature are based on that assumption. Certainly, they contain no guarantee of the indestructibility of species, or even of the whole complex of life. Yet they recognize a tendency to a regulation of interrelations which ultimately benefits both the species and the living community as a whole. Whether we like it or not, the fate of the individual is entirely subordinate to that of the species and the community. From a purely personal and selfish standpoint, that sometimes is a hard pill to swallow.

Applying these principles to life in the forest, we find that its every constituent organism has its function—a useful function in the perpetuation of the whole. Seeds germinate, seedlings sprout, they compete with each other for light and space, some die young, some grow old, but sooner or later they all disappear and a new generation of trees takes their place. In reality things are not as simple as that. Trees are only one element of the forest. In their shelter, there lives an immense and varied animal population, consisting of herbivorous and carnivorous species. Briefly, the herbivores live upon and control the vegetation, while the carnivores favour vegetation by restricting the multiplication of the herbivores. Out of this interaction of animals and plants arises a state of equilibrium preventing undue dominance of either and resulting in the perpetuation of both. By their very nature, all forest insects play an important role in this form of forest conservation. They are nature's first and best foresters, provided—they are not disturbed in the normal performance of their task. Disturbing influences may originate occasionally in the natural course of events, just as accidents will happen in "the best regulated family." More frequently, however, they are the work of man, whose ill-planned economy comes in conflict with that of the Natural Order.

I did not come here either to vindicate insects or incriminate man. Everything I have said until now represents a more or less frantic effort to dispose of the title of this lecture. I find myself in the same predicament as Bill Nye, the American humorist, who was asked to speak before a convention of Dairymen with the understanding that the subject of his essay would be "Milk." He opened his lecture with these words: "Ladies and Gentlemen, the best thing I have ever seen on milk was the cream."

After this remark, he did not mention "milk" or "cream" again during the rest of his talk,—I shall not go that far.

The generalities in which I have indulged thus far, will have a true bearing on our story when we come down to brass tacks. They are somewhat in the nature of what Jazz-band leaders call a "warmer-upper." They prepare the way for the real title of this lecture which should be: "The present great outbreak of the spruce budworm and what it means to the future of Canada's forest." In the spruce budworm, we find a factual demonstration, a case in point.

What is the spruce budworm? Perhaps, this question can best be answered by asking another: "How did the spruce budworm get its name?" Entomologists, who are usually matter-of-fact people, despise the name spruce budworm. They will tell you that it is a misnomer.

The first component "spruce" is misleading. The creature does eat spruce, both white and red. Black spruce appears on its menu more or less by accident. By all odds, however, balsam fir is its preferred food-plant. It is significant that extensive stands of mature and overmature balsam are generally considered to be the focal points of all our heavy outbreaks. Hence, "balsam budworm" would be a more appropriate designation.

The second component "budworm" is doubly misleading. It is true that in the very beginning of the feeding period buds are entered and destroyed either wholly or in part but, during the greater part of its activity, the so-called budworm feeds on the foliage of the new shoots and sometimes even on the foliage of the older twigs, when the supply of young and tender needles becomes exhausted.

Moreover, while the budworm is worm-like it is not a true worm. There are so many different kinds of worms that it is next to impossible to give a really comprehensive definition of a "worm"; nematodes and trematodes and cestodes and annelids, even sometimes bipeds are called worms. It is only when referring to the latter that we really know what we mean.

To say, as entomologists mostly do, that the spruce budworm is a caterpillar may be good entomology, but it is bad etymology. The word caterpillar means a hirsute cat. Our budworm is as naked as a plucked chicken, it has a sort of brownish coat, studded with a double row of white spots that look like buttons; two yellowish stripes running along the sides of the body just above the legs are suggestive of the decorations on the pants of a mounted policeman. To come to the point, the wormlike creature commonly referred to as the spruce budworm, is the immature stage or larval stage of an insect, the stage during which it does all its feeding

and growing. These larvae are usually active from about the end of April until the first part of June. When fully developed they are about 3/4 of an inch in length. Early in June they transform to pupae and, about ten days afterwards, they emerge in late June or early July as pretty, greyish or brownish moths, which are nocturnal in their habits and lay neat little rows of eggs on the needles of balsam and spruce.

Now, after all is said and done, what do you think comes out of these eggs? Just tiny nondescript, worm-like animals which, through force of habit and for want of any better name, we still will have to call "spruce budworms." And that's that for "the name of the beast."

After hatching from the egg, the larvae crawl about for some time in search of a protected place, where they spin a small web, a kind of cradle, in which they go to sleep for the rest of the summer and all the following winter. Somewhere, inside of themselves, they carry a thermostatically controlled alarm clock that wakes them up as soon as the weather is warm enough to cause the buds of balsam, or red and white spruce to swell and burst. Frequently, perhaps always, they begin their feeding by boring into an old needle or two which they hollow out more or less completely, for an "appetizer," as it were. Their real breakfast, or better, their continuous banquet commences when they penetrate the opening bud and attack the new foliage. From then on the story is like Major Bowes' wheel of fortune, "around and around it goes, and where it stops nobody knows."

More important, perhaps, than the "name of the beast" is "the number of the beast." It is evident that the author of the book of Revelation did not have the spruce budworm in mind when he said that the number of the beast was "Six hundred three score and six," else he would have put it at something like six hundred three score and six billions. And thereby, Ladies and Gentlemen, hangs the tale, a tale of woe if ever there was one. What insects lack in size, is more than made up by their numbers. The secret of their strength lies in their powers of multiplication. Create the necessary conditions, especially a superabundance of appropriate food, and you create an epidemic. That is exactly what has happened to the spruce budworm in this country. A very graphic account of the principal factors in the development of spruce budworm outbreaks in eastern Canada is found in Bulletin 37 (new series) of the Dominion Department of Agriculture. "There can be no doubt that budworm epidemics can develop only when there is sufficient balsam in the forests over wide areas. . . . . Early descriptions of the forests of Maine and New Brunswick indicate that they were composed largely of spruce and pine. Within more recent times the forests of Quebec were described as much the same. In other words, the percentage of balsam was relatively much less than just before the present outbreak. Early logging operations in these forests began in more accessible regions along the coasts and larger waterways. They

were intensely selective, since first the white pine was removed, and at later intervals the larger spruce, balsam being entirely disregarded. This selective cutting rapidly increased the percentage of balsam owing to the latter being left in the forest and to the better reproductive qualities of balsam under such conditions.

"The older epidemics followed the course of these logging operations, becoming more extensive as exploitation proceeded further into the virgin forests. At present few parts of the budworm-injured area have not been culled for the pine and larger spruce, producing a proportion of balsam sufficient to support the epidemic over the entire area, once it developed momentum in any section." What this really implies, can only be understood in the light of history.

The first authentic report of a spruce budworm outbreak dates back as far as 1807, when parts of Maine, New Brunswick and Quebec were affected. Information on this outbreak is rather fragmentary, how much damage was caused is unknown. Seventy years later—and this is important—seventy years later, another outbreak was active in the same general region. Damage was severe and extensive. This outbreak lasted probably about 4 or 5 years. Then, after a lapse of 30 years, the budworm again appeared on the scene. This was in 1909. It is difficult to understand how very few people realize what has transpired in the Canadian forests since that date. One outbreak after another has occurred in an uninterrupted series. Some 220 to 250 million cords of spruce and balsam have fallen prey to the budworm between 1909 and 1944. Statistics of this kind make little or no impression on our imagination. Let us put it another way. Suppose that all the spruce and balsam killed by the budworm in the last 33 years, (say 250,000,000 cords) were sawn into 4 foot logs. Suppose also, that after the fashion of piling a cord measure, we attempted to heap this wood in lots 8 feet long, 4 feet wide and 4 feet high, each pile being contiguous with the next. When our job is finished we would have a band of wood 4 feet in height and 60 feet in width, completely encircling the earth at the equator. In Ontario alone, since 1935, destruction of spruce and balsam by the budworm has been variously estimated at from 18 to 50 million cords. The area so devastated comprises some 15,000 square miles. Today, an additional 30,000 square miles is threatened with a similar fate within the next 4 or 5 years. To place a value in dollars and cents on these losses either to the Government in stumpage dues or to industry in raw materials, would be extremely difficult. Some parts of the destroyed forest had probably little or no commercial value, others, however, could have yielded substantial financial returns. Moreover such computations of these direct losses either in money or raw material are little better than a post-mortem. They are apt to obscure our understanding of the real issues involved. The repercussions of a budworm epidemic are felt for many years after the trees have died. Increased fire hazard is perhaps the most immediate

effect. It is humanly impossible to control a fire in an area littered with dead trees, nor is it usually possible to confine it to that area. Such fires burn with unbelievable intensity often causing serious damage to the site, after which floods and erosion put the finishing touch to this picture of desolation.

But the most far-reaching consequence of a budworm outbreak, and the one which should cause us more concern than any other, is the profound change in the composition of the succeeding stands. For years lumbermen, paper manufacturers, and foresters have noticed, with serious apprehension, the apparent inadequate regeneration of spruce and its consequent replacement by balsam in many forest areas. This state of affairs is by no means general, but it obtains in a great number of the most accessible localities. Although in recent years more balsam is used than previously in the manufacture of paper, companies still consider it as an inferior species, and justly so. They are forced by financial considerations to look upon spruce as their main supply of raw material.

Failure of spruce regeneration is attributed to several causes inherent in the species: (a) Inability of spruce seedlings to root in thick layers of moss, raw humus, or forest floor debris; (b) lower seed production than balsam (less frequent seed years); (c) lower degree of shade tolerance than balsam.

Two external factors should be added; namely, certain methods of cutting, and the spruce budworm. These are interdependent to a considerable extent.

It has been observed, over and over again, that after a budworm outbreak, the percentage of balsam in the new stand is considerably higher than it was in the old. The extraordinary accumulation of debris on the surface, while seriously hampering spruce regeneration, seems to offer no obstacle to the rooting of balsam. Root competition and competition for light causes further reduction of spruce that may succeed in becoming temporarily established. Generally speaking, the predominance of balsam is such as to reduce the possibility of its replacement by the residual spruce for several rotations if not forever. Under absolutely normal conditions, it is conceivable that sooner or later—in some localities— a spruce climax might develop from such antecedents. When the spruce budworm, however, enters into the picture, all such hopes vanish. It is a conservative estimate—probably an understatement—to say that, in many regions, any forest containing over 30% of balsam is more than likely to succumb to budworm attack upon reaching maturity. When this happens, not only the balsam but the greater part of the spruce associated with it will be killed and the forest will enter a new and more advanced stage in the succession towards a balsam climax. Although a great deal more could be said about the nature or the causes and effects of spruce budworm out-

breaks, I wish to devote some time to a discussion of the ways and means of dealing with the problems of control and prevention. In other words: What can be done to remedy or alleviate the present situation?

As you may well surmise, many suggestions have been received from earnest and well-meaning people. Among others, one man suggested that a "Swat-the-budworm" campaign might be just as effective as the "Swat-the-fly" movement of a few years ago. Probably, that is quite correct! Perhaps we could improve on this, by suggesting a "budworm tax." There appears to be a real precedent for such action. Head-lice were a source of great tribulation to the Peruvian and Mexican tribes of American Indians. To cope with the evil, one of their monarchs conceived the idea of imposing a "head-tax" of lice on his subjects. So, we are told that bags full of these questionable treasures were found in the palace of Montezuma! What a relief it would be if Mr. Ilsley could be persuaded to accept budworms in payment of our income tax!

More serious proposals regarding biological and artificial control have not been wanting. Control by parasites and by the distribution of insecticides has definite possibilities, but only if considered with an eye to the future. The idea that extensive infestations such as the one now active in Ontario can be brought down by these methods is unwarranted. However, experimental work in both these fields should and will be undertaken in Canada and the United States, in view of their future possible usefulness.

But, as Lamartine would say: "Revenons à nos moutons!" The first thing to be remembered in connection with the control of budworms and of the majority of insects, is the old adage: "An ounce of prevention is better than a pound of cure." Once a budworm outbreak gains sufficient momentum, any attempt to put a stop to it is utterly futile. In the past, it has been our sad experience that no one is interested in forest insect outbreaks until they are well out-of-hand. As a result the idea of prevention has played only a minor part in applied entomology, control was the need of the hour and it took precedence over everything else. Until the emphasis is shifted from control to prevention, we shall accomplish little or nothing in forest entomology. Notwithstanding the compelling logic of this procedure, it is extremely difficult for the entomologist to sell it to his clients or financial backers. Few people, indeed, can be made to realize the importance of studying the biology and ecology of an insect whose activities are in abeyance, and, by the same token, it is even more difficult to convince them of the necessity of instituting remedial measures as a precaution against infestations which are merely potential.

Yet that is precisely what we shall be obliged to do in combatting the spruce budworm. We cannot afford to be content forever with salvaging

the wreckage left in the wake of this pest. It seems highly probable that, as the years roll on, the frequency and intensity of budworm outbreaks will increase with each successive generation of balsam. The history of the insect during the last 140 years strongly supports this contention.

The conditions favouring budworm outbreaks in Eastern Canada are already so widespread that our chances of counteracting them are growing poorer and poorer, day by day. Unless immediate and drastic steps are taken, the problem will be beyond solution before many years. These conditions are to be found in the forest itself. No doubt, they are attributable in part to the very nature of the competing tree species, but they have received a tremendous stimulus from the logging operations of the past, when pine and spruce were cut and balsam was left to restock the cut-over areas. The forest, as a whole, has lost its resistance to budworm attack. The only way to restore it is to re-adjust the balance of the spruce-balsam association through the institution of appropriate methods of forest management.

For years, forest entomologists have advocated certain general procedures in forest management for the prevention of budworm attack. They can be classified under three main headings:

(1) Prompt removal of mature and over mature balsam stands.

(2) Utilization on short rotation of younger and more vigorous balsam stands.

(3) Fostering regeneration of better species, particularly spruce.

Little heed has been paid to these suggestions. Up to the present time, forest management generally has been looked upon as a matter of academic interest but of little or no practical value. The main argument against silvicultural management is that, if it means a higher logging cost now, under the system of short-term finance in vogue today, the more remote benefits to be derived do not adequately compensate for current losses. Actually, inasmuch as most of our forests are public property, their maintenance, improvement, and conservation are primarily functions of the "powers that be" but the licensees should and do assume a fair share of these responsibilities.

It is the considered opinion of forest entomologists and of many others, that co-operative action on the part of the government and the industry could bring about the institution of a mutually beneficial system of forest management which would result not only in protection against budworm attack, but in the general improvement of forest conditions.

To anyone taking a realistic view of such a proposal, it is quite evident that some radical departures from established practices in forest exploita-

tion and some fundamental changes in forest policy will gradually impose themselves. The burden of such should, at all times, be fairly shared by the public as a means of protection of a national asset and by the industry as a security for its investments. Some of the requirements in the sort of forest management here proposed are merely expansions or improvements of existing procedure, others are complete innovations. I shall endeavour to outline briefly the main points of such a programme:

(1) Complete and accurate forest inventories, kept up-to-date by periodic revisions. A knowledge of the composition, the age, the density, etc., of the forest is indispensable in the determination of budworm hazard.

(2) An adequately organized—country wide—forest insect survey. Although great progress has been made in the development of a National Forest Insect Survey, there still is ample room for expansion and improvement.

(3) Intensified research in all branches of forest biology and ecology (or more specifically in the fields of entomology, pathology, plant physiology, biochemistry, toxicology, etc.). This is simply an admission that we do not know everything that should be known to combat the spruce budworm successfully. For instance, whilst we know the conditions under which the spruce budworm epidemics arise, we know, as yet, nothing about their true causes.

(4) Studies of appropriate methods of forest utilization to ensure the attainment of the object in view; namely, increased resistance to budworm attack.

(5) Studies in spruce regeneration.

(6) Development of transportation facilities in the forest through the construction of permanent roads and stream improvements. The establishment of permanent forest communities seems to be an integral part of such a proposal.

Whether we like it or not, nature has ordained that the greater part of Canada will always be a forest region, and we shall have to develop it as such on a permanent basis. "Permanency" should be the corner stone of our edifice. Permit me to quote a prominent Canadian forester on this all-important subject: "Our forest industry, though the largest of all our industries in the volume of its invested capital, in the volume and value of its yearly production, in the number of its employees, and in its share of our natural resources, is still on a weak basis as regards its stability, its long-term planning, its social and economic functions. It has not yet considered effectively its permanency which, owing to its specific nature, should be one of its prime objectives in the economic development of this country . . . We are not yet out of the pioneering stage, which is distinguished by unlimited use of our natural resources, with no provision for

the future. We still regard as the higher form of progress the building of a new industrial wood-working plant in some remote and unsettled territory, and seem to fail to observe that it is, more often than not, counter-balanced by the closing of former prosperous communities, dependent on a well-wooded back-country. Forest industries prefer to move rather than create at their own doors." There is a great deal of truth in that statement, but, in my humble opinion, industry alone should not be made to carry the onus of the charge. The development and protection of our forest resources through the construction of permanent roads and stream improvements and the establishment of permanent forest communities makes up the greater part of what seems a very ambitious programme. Viewed in conjunction with our need of a post-war rehabilitation scheme, it opens up the prospect of permanent and satisfying employment to many thousands of men returning to peace-time pursuits.

(7) (And here I am skating on thin ice.) Revision of forest laws and regulations in the light of modern advances and with a view to meeting the exigencies of the hour. People are averse to changing the statutes of the land, and rightly so; there is something sacrosanct about the law. At the same time, there is always the danger of becoming ultra-conservative. I hope that no one will accuse me of irreverence if I go so far as to suggest that the cause of forest conservation would be served most effectively, if we could have an eleventh commandment: "Thou shalt not kill the goose that layeth the golden egg."

The execution of such a plan as the one we have outlined, will depend on a number of essential prerequisites. Suffice it to mention two of them.

If the utilization of balsam fir is the key to the budworm problem, we are confronted with a serious obstacle in that balsam is inferior to spruce in the manufacture of pulp and paper. It would seem imperative that new uses for balsam be found as soon as possible. A few years ago, such a suggestion might have appeared utopian and outlandish. Today, however, when we hear of startling new discoveries in industrial chemistry at every turn, when we are told of what has been done with the humble milkweed and the soy-bean, is it unreasonable to expect similar results from intensive research on balsam? It is impossible to overemphasize the importance of this approach to the budworm problem.

The other prerequisite, and perhaps the most important of all, is the creation of forest-consciousness in the people of Canada. For years, newspapers, magazines, radio, organizations of many kinds, have been actively engaged in spreading excellent propaganda. All this splendid effort cannot be too highly commended, but it has not always achieved its objectives. Often it is too one-sided and mainly addressed to adults. We have put the cart before the horse. The only effective way to reach the

entire population of a country is through the public school system and the organization of youth movements. *Experto Crede Adolpho!*

Undoubtedly, forest insect outbreaks are a problem for entomologists and foresters, but they are, even more so, a problem for the whole Canadian nation. Without the moral and financial support of all concerned little can be accomplished by scientists, no matter how enthusiastic and well-intentioned they may be. The government, both Dominion and Provincial, the paper and lumber industries, every man-in-the-street who has a stake in the present and future welfare of this country must lend a helping hand. The great danger in this, as in any other enterprise involving numerous and varied interests, lies in that fatal foible of men, that beloved indoor sport commonly referred to as "passing the buck." As a forest entomologist,—and I speak for all my colleagues in the profession, —I have no objection to holding our metaphorical animal either by the head or the tail, but I do refuse to accept the monopoly of its custody. In a democracy the voice of the people is the voice of God. Let it become articulate and force the issue. It is not enough to be aware of the gravity of the situation. Action must be taken, and taken promptly. It is up to the Canadian people to decide once and for all whether the forests of this country shall be managed by the budworm or by man, whether they shall be mined or be cropped, whether they shall persist or whether they shall perish!

"The Living Landscape"

PAUL B. SEARS, A.B., B.S., Sc.D., Ph.D.

Professor of Botany, Oberlin College, Oberlin, Ohio.

March 18th, 1944.

Man is not a mere observer or manipulator of the landscape, but a part of it. His destiny is interwoven with that of the physical world about him. He has become the dominant species on earth, and an agency of stupendous change. Unless the changes which he produces are controlled by intelligence and a humane spirit, his own future is menaced.

It is to the pattern of the natural world, where man has not yet disturbed the orderly processes of nature, that we must look for principles to guide us. The ruthless competition of which we hear so much is only part of the story. In natural communities of plants and animals there prevails a trend towards an increasingly efficient use of energy. Collaboration, adjustment, even mutual aid within animal species are principles as profound as competition.

In general terms the welfare of a species rests upon three factors: resources, population, and culture. It is through our culture that we influence, and are influenced by, our environment. In the United States there are outstanding examples of the disastrous as well as the beneficial operations of this principle.

The most glaring example of man's misuse of his environment is the semi-arid West. Originally this area presented a picture of order, not disorder, with the prairie grasses and legumes binding and enriching the soil. Then in spite of warnings it was "mined," planted to wheat, and with the coming of the dry years the soil started to blow, resulting in dust storms, erosion over vast areas, and the washing away of good top-soil down rivers and streams where the mischief was continued by the destruction of fish life. It has been said that one could stand on the bank of the Mississippi and see a forty acre farm float down every hour.

Similar destructive scenes can be observed in South Carolina. New Englanders hung on to their worn-out farms by the skin of their teeth believing that rocks grow up through the soil though ecologists knew that the appearance of the rocks came through the washing away of top-soil. Owing to the same cause, in Ohio and elsewhere, where there used to be springs on every farm, the water table is dropping at the rate of a foot a year and water has to be hauled from distances.

As a contrast there are communities where intelligence and co-operation are reflected in the landscape. The husbandry of the Pennsylvania Dutch was reflected in a fruitful landscape where every hill-top is crowned with trees, protected from fire and marauding cattle; every hill-side covered with well-fenced, well-fertilized pasture on which contented herds are well fed by being moved from one to another so that grass may grow; only the lower and more fertile ground being cultivated, and that with scientific care and common sense.

It is only by understanding laws which were in operation long before we existed that we can re-establish order within the living landscape of which we are a part.

"Gems—Luxury to Utility"

EDWARD H. KRAUS, B.S., M.S., Sc.D., Ph.D., LL.D.

Dean of the College of Literature, Science, and the Arts, University of Michigan, Ann Arbor, Michigan.

March 25th, 1944.

In recent years gems previously associated with ornamentation and luxury have become of the utmost importance in industry and the war effort. Diamonds, sapphires, rubies and, more recently, rock crystal have become highly important in our mechanized civilization.

Rock crystal is a clear transparent variety of quartz which has for centuries been used for necklaces, as crystal balls, and for carved statues and ornaments. Almost over night it has become essential in so many ways that there are some people who believe we are about to move into a crystal-controlled world. From it come thin crystal wafers, the oscillating plates indispensable in frequency control in radio, radar, artillery range-finding, and submarine detection. Under the impetus of war, one firm in New York turns out as many of these plates in a week as were produced in the United States in 1939. The supply of rock crystal, which has come mainly from Brazil, is not inexhaustible and the urgent demand for it has resulted in the institution of search parties in many parts of the world.

The use of diamonds in industry, which before the war was mainly in drilling, is now extremely important in precision machining of auto and aeroplane motors, enabling them to be run at high speeds immediately upon delivery instead of waiting for the once-essential breaking in or conditioning.

For the drawing of wires and filaments for electrical apparatus extremely small diamond dies are used through which wires as fine as one-seventh the diameter of a human hair is drawn. The use of bonded diamond wheels during the last eight years has increased at an astounding rate. Diamond-set tools play an important part, directly or indirectly, in the manufacture of most articles in common use. Fortunately the United Nations virtually control the world supply of diamonds. Borneo, the only diamond-producing area in control of the Axis powers, yields only two one-hundredths of the world's supply. Germany in desperation has resorted to securing gem stones from its citizens and using them for industrial purposes.

Synthetic sapphires and rubies are essential in the manufacture of aeroplanes, radio, and other war apparatus. They are used in large quan-

tities for jewels and bearings in watches, chronometers, and in the instrument boards of aeroplanes. France, Switzerland, and Germany were the main pre-war sources of supply and with the invasion of France a critical shortage was faced. It was necessary to develop an entirely new industry for their manufacture, and for a time even the success of the war effort was threatened. But progress both in Britain and the United States was so quick that present needs are being adequately met. Diamonds, sapphires, rubies, and rock crystal have become so vital to our war effort that ultimate victory may depend on having a sufficient supply.

ELECTED TO HONORARY MEMBERSHIP

in the

ROYAL CANADIAN INSTITUTE

These recommendations were approved by the Council and in accordance with the Constitution of the Royal Canadian Institute the names were presented at the Nineteenth Ordinary Meeting, held on March 25th in Convocation Hall.

Election took place at the Annual Meeting, April 15th, 1944.

JAMES BRYANT CONANT, A.B., Ph.D., LL.D., L.H.D., D.C.L., Sc.D.

Born in Boston, Mass., in 1893, James Bryant Conant attended Harvard University, receiving his A.B. in 1913 and his Ph.D. in 1916. In the same year he was appointed Instructor in the Department of Chemistry at Harvard University, and thereafter proceeded through the various steps in his academic career to a professorship in 1927. In 1929 he became Sheldon Emery Professor of Organic Chemistry and in 1931 he was also appointed Chairman of the Department of Chemistry. He is the author of "Organic Chemistry", which appeared in 1928, and "The Chemistry of Organic Compounds", published in 1933, as well as other important scientific books. He has presented numerous technical papers, many of which have appeared in the *Journal of Biological Chemistry;* and at the close of his professorial career he was working upon the chemical composition of chlorophyll and hemoglobin.

Dr. Conant is looked upon as one of the world's authorities on organic chemistry and biochemistry. He has been granted honorary degrees from some twelve universities and the Royal Canadian Institute honours itself in conferring Honorary Membership on Dr. J. B. Conant.

OTTO MAASS, B.A., M.Sc., Ph.D., F.R.S., F.R S.C., F.C.I.C.

Professor Otto Maass was born in New York in 1890. Educated at McGill, Berlin, and Harvard, he joined the staff of the Chemistry Department at McGill in 1917, and became Macdonald Professor of Physical Chemistry in 1923, and Chairman of the Department in 1937. He was elected a Fellow of the Royal Society of Canada in 1932, and of the Royal Society of London in 1940.

Long recognized as the outstanding Canadian physical chemist, Professor Maass' main contributions have been on the properties of gases, the critical state, and the physical chemistry of cellulose. His influence on Canadian chemistry has been profound. The graduate school which he built up at McGill in the early 1920's was really the beginning of organized university chemical research at McGill, and his former students are now on the staffs of the majority of Canadian universities, many American universities, and a wide variety of industrial laboratories.

As Professor Maass has had a very intimate acquaintance with the various Canadian chemical organizations, the chemists look to him to lead in chemical work related to the war. His activity in this work led to his appointment as Director of Chemical Warfare of the Department of National Defence. In this position and in his relations with the National Research Council he has taken the leading part in the organization of university chemical research on war problems and in chemical matters relating to the armed forces.

It is doubtful if another Canadian could be found whose individual influence on his profession has been more far-reaching.

CHALMERS JACK MACKENZIE, C.M.G., M.C., B.E., M.C.E., D.Sc., LL.D., F.R.S.C.

Chalmers Jack Mackenzie is a striking example of a Maritimer who has won distinction in the more westerly provinces. Born in St. Stephen, N.B., he received his B.E. degree from Dalhousie University in 1909 and his M.C.E. from Harvard in 1915.

Although he began his professional career in the Maritimes, he moved west in 1910, becoming resident engineer in charge of three municipal electric plants. During the winter of 1912-13, he inaugurated the engineering courses at the University of Saskatchewan, and was appointed Professor of Civil Engineering in 1915.

When the first world war broke out he was also a member of the consulting engineering firm of Maxwell and Mackenzie, with headquarters at Edmonton, and was engaged in designing and constructing waterworks, sewer systems, sewage disposal plants and electric power plants.

From 1916 to 1918 he was on active service overseas with the 54th Battalion, C.E.F., and was awarded the Military Cross.

During the period from 1919 to 1939, Dr. Mackenzie was active in many spheres. He was primarily concerned in the field of education, having become the Dean of the College of Engineering of the University of Saskatchewan in 1921. Under his guidance the College established a remarkable record for growth and stability.

Meanwhile he conducted an important consulting engineering practice, including the design and construction of two large reinforced concrete bridges over the North and South Saskatchewan Rivers at Saskatoon. He was also chairman of the Saskatoon City Planning Commission, an alderman of the City of Saskatoon, chairman of the Board of Directors of the Saskatoon City Hospital, a member of the Saskatchewan Council of Public Health, and a member of the Saskatchewan Drought Commission.

Upon the departure of Lieutenant-General McNaughton in 1939 to take command of the Canadian Army overseas, Dr. Mackenzie became Acting President of the National Research Council, having been a member of the Advisory Council since 1935.

He has been active in the professional organizations, having been President of the Association of Professional Engineers of Saskatchewan in 1930 and President of the Engineering Institute of Canada in 1941.

Indicative of this activity are the many papers that have been presented by him to scientific and engineering societies over a long period.

Many honours have come to Dr. Mackenzie. He has been awarded the honorary degree of Doctor of Laws by Dalhousie University and the University of Western Ontario and that of Doctor of Science by McGill University. In June, 1943, he was granted the C.M.G. in the King's birthday honours. He has been admitted to a Fellowship in the Royal Society of Canada and has very recently been awarded the Sir John Kennedy medal of the Engineering Institute of Canada in recognition of outstanding merit in the profession and of noteworthy contribution to the science of engineering.

ROBERT CHARLES WALLACE, C.M.G., M.A., B.Sc., D.Sc., Ph.D., LL.D., F.G.S., F.R.S.C.

Born at Orkney, Scotland, Robert Wallace inherited the Scotch tradition of simple living and high learning. The breadth of his education and the excellence of his ability may be judged from his university record: M.A., B.Sc., and D.Sc. from Edinburgh, and Ph.D. from Göttingen University. In his day Göttingen, like many other German universities, had high standards in scientific work, and Dr. Wallace's record at this university fully upheld Scotland's reputation for high scholarship.

Dr. Wallace was Exhibition Scholar from 1908 to 1910 and Carnegie Fellow in the last year. He was Demonstrator in Crystallography in St. Andrews University for two years, and he then left his native land to make his reputation in Canada. He was appointed Lecturer in Geology and Mineralogy in 1910, in the youthful University of Manitoba, and two years later advanced to Professor, a position he held for sixteen years, when he left Manitoba for the presidency in Alberta. That he was an inspiring teacher of geology and mineralogy while in Manitoba, is attested by students who had the privilege of studying under him.

Throughout his career in Canada Principal Wallace has been very active in public affairs. From 1918 to 1921 he was Commissioner of Northern Manitoba; in 1927-28 Commissioner of Mines for Manitoba; in 1924 President of the Canadian Institute of Mining and Metallurgy, and in the following year President of the Educational Association of Manitoba. In 1930 he was elected President of the Association of Canadian Clubs, and ten years later President of the Royal Society of Canada. His interest in public affairs and his ability as an organizer soon brought a call to higher executive positions in the educational field. Before he became burdened with executive duties, he contributed many valuable articles to the scientific journals in his special field of geology. He is at present Chairman of the government's Committee on the Utilization of our Natural Resources in connection with post-war planning.

Dr. Wallace was President of the University of Alberta from 1928 to 1936, when he was called to Queen's as Principal and Vice-Chancellor. Many Canadian universities have honoured him with the LL.D.—Manitoba in 1928, Queens' in 1930, Toronto in 1932, and Saskatchewan and McMaster in 1936. In the King's birthday honours this year he was granted the C.M.G. for his work in education in Canada.

On two occasions in recent years Principal Wallace has addressed the Royal Canadian Institute and we shall be honoured in numbering him among our Honorary Members.

SIR ROBERT ALEXANDER WATSON WATT, F.R.S., M.I.E.E., F.R.Ae.S., F.R.Met.Soc.

It is common knowledge now that the Battle of Britain was won by the help of the radio locator, a secret device that enabled the R.A.F. fighters to be warned of the approach of enemy planes in time to go up to meet them. It is not so well known that the credit for this preparation of defence of Britain in the air goes almost entirely to one man, Sir Robert Alexander Watson Watt whom we are honouring tonight.

Sir Robert was born in Brechin, Scotland, in 1892 and was educated in University College, Dundee, and the University of St. Andrews. He graduated in electrical engineering but became interested, at an early age, in meteorology. He was meteorologist in charge of the Royal Aircraft Establishment from 1917 to 1921, Superintendent of the Radio Research Stations of the Department of Scientific and Industrial Research from 1921 to 1933, and Superintendent of the Radio Department of the National Physical Laboratory, London, from 1933 to 1936. At present he is Scientific Adviser to the Air Ministry (London) on telecommunications and Vice-Controller of Communications Equipment for the Ministry of Aircraft Production.

In the early days radio scientists, in trying to explain the mechanism whereby wireless telegraphic signals are transmitted over long distances on the surface of the earth, were led to the conclusion that there existed at a great height in the earth's atmosphere a layer which was electrically conducting and which acted as a reflecting surface for radio waves. Experiments first carried out in England by physicists at Cambridge and Peterborough showed that radio waves sent out from one of these stations were received back at the other station after reflection from some place in the higher atmosphere. Noting the time interval between sending and receiving the message and assuming that the message travelled with the speed of light, it was calculated that this upper layer was situated at a distance of about 100 miles above the earth's surface. The surface is the so-called heaviside layer.

As a young man Sir Robert became interested in this reflection of radio waves and has followed this line of work ever since.

From his interest in meteorology he conceived the idea that he might be able to locate distant thunderstorm clouds and follow their path in the air. It is said that in the course of this work he found that the signals were interfered with by airplanes flying at random across the path traversed by his radio waves. He conceived the idea that he might determine the distance of the planes by this means.

At the beginning it was thought that there were two insurmountable difficulties in the way of success. In the first place the energy reflected by an aeroplane is only about one millionth of a millionth of a millionth of the amount of energy sent out into space as the incident wave. By others than Sir Robert it was considered impossible to make any record of such a weak return signal. The second difficulty was the necessity of being able to measure very small intervals of time. These waves travel to and fro at the rate of 186,000 miles per second; so, in order to get a return signal from a plane five miles away, one would have to be able to measure to about 1/20,000th of a second, or 5 micro-seconds.

These were the problems Sir Robert solved almost single-handed. He convinced the Air Ministry of the day (in 1935) that there was a great future in this device for air defence. He and a few intimates, including his wife, worked feverishly and in the greatest secrecy under the wing of the Air Ministry and the results proved that, at least in one respect, Britain was prepared for war.

Not only were the years 1935 to 1939 full of hard work and scientific romance but, ever since, this field has developed with ever increasing momentum and usefulness. This war is in fact a radio war.

When France fell the secrets were divulged to the Germans and in June 1941 the first official public announcement of radio location was published by the British Government. When the United States entered the war full details were divulged to them and the industrial energy and scientific enthusiasm of both Canada and the United States has added greatly to the whole field, now known as Radar.

Sir Robert has visited this continent on several occasions and is still the mainspring of the whole allied organization dealing with radar. In honouring him we are adding to our roll of honour a name that will long adorn the pages of history.

C. H. BEST A. R. CLUTE H. J. LAMB
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Membership

(1) Ordinary members are entitled to all privileges of membership, the annual fee being five dollars. Applications for ordinary membership are passed upon at the regular meetings of the Institute.

(2) Associate members are ladies who do not desire full membership. They are admitted in the same way as Ordinary members, the annual fee being two dollars and fifty cents.

(3) Life members are elected in the same way as Ordinary members, the Life membership fee being one hundred dollars.

For further information relating to membership or to the activities of the Institute, address letter to

THE SECRETARY,
The Royal Canadian Institute,
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of the

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as of August 8th, 1944

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OF THE

Royal Canadian Institute

SERIES IIIA · SESSION 1944-45 VOL. X

This publication is issued with the object of conveying a general idea of what the Royal Canadian Institute endeavours to do, along with a brief outline of what it has done in the past. The publication contains abstracts of the popular scientific lectures given each Saturday Evening in Convocation Hall, University of Toronto, during the 96th Session, 1944-1945.

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CONTENTS

Page

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THEN AND NOW

THE Royal Canadian Institute has as its object the promotion of science and the results of scientific research. It attempts to inform and educate the public on important matters of general interest; to stimulate research and to act as liaison between the scientist and the public.

The Institute was established in 1849 in Toronto, at that time the capital of Upper Canada, by a small group of surveyors, architects, and civil engineers. When incorporated in the Province of Upper Canada in 1851 it was definitely to serve Upper Canada, which, in the enlarged Dominion of Canada, came to be the Province of Ontario. If it had been established after Confederation it is likely that it would have been called the Ontario Institute.

The original members of the Institute were William E. (later Sir William) Logan, John O. Brown, Frederick F. Passmore, Kivas Tully, William Thomas Ridout, and Sandford (later Sir Sandford) Fleming. Of these, Sir Sandford Fleming, the originator and founder of the Institute, was the last survivor.

A story of interest from the pen of Sir Sandford Fleming, a great Canadian and a pioneer in engineering, describes the enthusiasm of the early founders:—On February 8th, 1850, a meeting was held to discuss plans for the newly formed organization. Only two members attended, F. F. Passmore and Sandford Fleming. The prospects of the young Institute were not brilliant, but the two determined to act with energy, if not with entire regularity. After much silence and long waiting in vain for other members to appear, the one addressed the other in these words: "This looks bad—we must, however, proceed, as the saying is, to make a spoon or spoil the horn. Let one of us take the chair and the other act as secretary," and so agreed, dispensing in the emergency with a quorum, they passed a series of resolutions with complete unanimity. No amendments were offered and time was not spent in long discussions; those present deemed it a dispensable formality to have "movers" and "seconders" to the motions submitted. As appears by the minute book the meeting simply "resolved" this or that. One resolution adopted and formally placed on record, reads: "Resolved, That the members of the Canadian Institute do after this date meet once a week, on each Saturday at 7 o'clock p.m., in the Hall of the Mechanics' Institute. The first meeting to take place on Saturday next, February 16th, 1850." No fault was ever found with the action taken on that occasion and meetings have been held without interruption since that date.

At the earlier meetings, papers on scientific problems of the day were read and discussed and laboratory work was carried on by the various sections which were established under the administration of

the Institute. The most important of these were the Biological Section, the Geological and Mining Section, and the Historical Section.

The early publications of the Institute, beginning with the year 1851, were also of great value because they were the only ones of their kind in the scientific field in Canada. The first of these publications, "The Canadian Journal: a Repertory of Industry, Science, and Art," was edited by Henry Youle Hind, who conducted explorations in western Canada, and there followed the well-known series on "Toronto of Old" by the Rev. Henry Scadding, D.D., who was President of the Institute from 1870 to 1876.

When the Canadian Institute moved from its building at the corner of Richmond and Berti Streets in Toronto in 1905 to become more closely associated with the University of Toronto it began to establish a more direct communication with the public. On April 2nd, 1914, His Majesty the King granted permission to the title "Royal" and it became the Royal Canadian Institute.

In aiding the public to appreciate and understand the value of research, the Institute has had an important influence in increasing research facilities in Canada. During the First World War the Royal Canadian Institute established a Bureau of Scientific and Industrial Research to promote closer co-operation between science and industry in the prosecution of the war. As a result of publicity given to the value of enlisting scientific aid in the war effort, the federal government appointed an Honorary Advisory Council on Scientific and Industrial Research which later developed into the National Research Council with extensive laboratories in Ottawa. Public realization of the value of science after the war led to the establishment of the Ontario Research Foundation and to increased grants for research in the universities.

During the last few years the Institute has been playing an important part in the promotion of the conservation of our natural resources. It co-operated in the formation of the Guelph Conference organized to study these problems and make representations to the Provincial Government.

Scientific research was never more necessary than it is to-day in enabling us to develop the resources of our country so that they will yield the greatest possible return. The public should be enlightened on the applications of science to modern problems.

The contributions of science to our material welfare are, however, only a part of its significance to mankind. Probably even more important is its general educational value. It opens to us a broader vision of the world, developing more accurate habits of thought, and thus leading to a greater enrichment and enjoyment of life. For these reasons the educational work of the Royal Canadian Institute is one of the most valuable of its activities.

Some of the Outstanding Accomplishments of the Royal Canadian Institute

1. Co-operation in promoting the meetings in Toronto of the following scientific societies.

(a) The American Association for the Advancement of Science, 1889 and 1921.

(b) The British Association for the Advancement of Science, 1897 and 1924.

(c) The International Geological Congress, 1913.

(d) The International Mathematical Congress, 1924.

2. Standard Time.

In 1878 Sir Sandford Fleming brought forward the plan of adopting for the whole earth twenty-four standard meridians, fifteen degrees apart in longitude. He published many papers on this subject, and with the co-operation of the Institute, the zone system of time-reckoning was adopted in most of the countries of the world.

3. The Museum.

The Ontario Archaeological Museum was begun under the auspices of the Institute, and continued under its management for six years before being transferred to the Ontario Government and the University of Toronto.

4. The Ontario Good Roads Association.

The Ontario Good Roads Association was organized as the outcome of a meeting called by the Canadian Institute in 1894.

5. Publications.

The publications of the Institute have appeared as follows:—

(1) "The Canadian Journal: a Repertory of Industry, Science, and Art," and a Record of the Proceedings of the Canadian Institute. 3 vols., 4to. Begun August, 1852, ended December, 1855.

(2) "The Canadian Journal of Science, Literature, and History." 15 vols., 8vo. Begun January, 1856, ended January, 1878.

(3) "Proceedings of the Canadian Institute," 7 vols. Begun 1879, ended April, 1890.

(4) The Archaeological Reports of the Canadian Institute were published as part of the Appendix to the Report of the Minister of Education for the Province of Ontario, 1886-1894.

(5) Minor Series. "Proceedings of the Canadian Institute." From 1897 to 1904, two volumes of this series, containing short papers, were published.

(6) "Transactions of the Royal Canadian Institute." Begun October, 1890, and up to October, 1944, Part 1 of the twenty-fifth volume has been published. This publication contains scientific papers on technical subjects, relating to all branches of science. These papers are submitted by those doing research work. The publication is sent to learned societies throughout the world, and these societies send their own publications in exchange. Any Ordinary member of the Royal Canadian Institute may receive a copy of this publication upon request.

(7) "Proceedings of the Royal Canadian Institute." Series IIIA. Abstracts of the lectures given during the year. Begun 1936 and to date ten volumes have been published.

(8) General Index to Publications, 1852-1912. Compiled and edited by Dr. John Patterson. Dr. J. B. Tyrrell, President of the Institute, 1910-1913, undertook to finance the compilation of the index, and made it possible for the Council to proceed with the work.

6. The Library.

As a result of the exchange of publications with learned societies for the past ninety-six years, the Institute has built up a most important scientific library containing thousands of volumes which are indispensable to scientific workers and are not otherwise available in this part of Canada. This library is housed in a section of the library of the University of Toronto, and may be used by the staff and students of the University as well as by members of the Institute.

7. The National Research Council and the Ontario Research Foundation.

It was in large part due to the vigorous campaign of the Institute on behalf of a wider application of science to industry in Canada, that the Honorary Advisory Council for Scientific and Industrial Research, the forerunner of the National Research Council, was appointed by the Dominion Government, and that the Ontario Research Foundation was instituted through the co-operation of the Ontario Provincial Government and manufacturers.

8. University Grant.

The Institute also strongly supported the successful application to the Provincial Legislature for an annual grant for research in the University of Toronto.

Report of the President

1944 - 1945

As presented to the 96th Annual Meeting, Saturday, April 7th, 1945, held in the Royal Ontario Museum.

The close of the ninety-sixth session of the Institute finds us still at war, but with the most promising prospects for peace in the near future, or at least for the cessation of large-scale military operations in Europe. We have still, however, a long and difficult road to travel before numerous major problems will be settled and we can turn to the solution of domestic problems which concern us individually and as members of the Royal Canadian Institute. Our organization is concerned with projects which will improve the standard of living for our people through conservation; and research in science and industry, that will help us make the best possible use of our raw materials, thus providing more employment for our citizens. Our efforts in this direction are reflected to a considerable degree in the character of our Saturday evening lectures as well as in the part played, on a number of occasions in the past, in initiating or supporting organizations established to aid such projects. A recent report by the Guelph Conference shows that the Institute was one of its parent organizations. Great interest in conservation has been stimulated by the Conference and the Provincial Government and other institutions have taken up the challenge to do something about this very important matter.

So many of our members have, this year as in recent years, been overloaded with duties because of the war, that no new major project has been initiated. Further, the necessity of arranging for new headquarters for the Institute and plans for the celebration of our Centenary in the near future have consumed much time of some members of the Council and other members. It is a pleasure to report, however, that the Institute has enjoyed a very successful year when judged by the interest shown in its activities and the enthusiasm for its work. Its contacts have broadened and its influence in the community, which has been increasing through the years, has continued to grow.

The Saturday evening lecture programme has become famous at least on this continent. It is a tribute to the Institute that many of the continent's leading scientists, engineers, and industrialists express a willingness to appear on our programme, and they take great pains to make their lectures interesting and instructive. Many of them have written regarding the fine attitude of our audiences. There should be a wonderful opportunity after the war, when our scientists can talk freely about their recent discoveries, to have our people informed on many matters which will greatly affect our future mode of living.

The lecture programme is a very important feature of the Institute's work but we should not be content with just a lecture course. When peace is restored, our society may, as it has in the past, help to implement many projects which will aid Canada's progress.

The speakers in our lecture series this year came to us from Great Britain, China, the United States, and Canada, and they spoke on a great variety of subjects. It was a pleasure to have joint meetings with the Toronto Centre of the Royal Astronomical Society of Canada, the Toronto Section of the American Institute of Electrical Engineers, and the Toronto Section of the Chemical Institute of Canada. The twenty lectures were on the whole remarkably well attended. Since there are many people in Toronto who have not the faintest conception of the public appeal of the Institute's lectures it may be of interest to record that the average estimated attendance for the session was over 1,200 with a total of over 24,000 persons.

We held one ordinary meeting which was unique in the annals of our society. At that meeting the University conferred the Honorary Degree of Doctor of Science upon one of our very distinguished Honorary Members, Sir Robert Watson-Watt, at a special convocation.

The installation of a good loud-speaker system has added greatly to the interest and pleasure of the members of our audience. After prolonged investigation, modern equipment was purchased, installed in Convocation Hall, and presented to the University. This was obtained at a cost exceeding by only $25 what we had been paying in annual rental for similar equipment.

Our speakers were all entertained by members of the Council and others through arrangements ably made by our Entertainment Committee of which Dr. E. W. McHenry was the Chairman.

The Institute is again deeply indebted to Dr. T. A. Davies for graciously providing the music which is so much enjoyed at our Saturday evening lectures.

Good publicity has played a very important part in the success of the meetings and we are grateful for the splendid support given our work by the city papers. Each of the leading dailies published an editorial on the Institute before the opening of the lecture course, and good reports of nearly all lectures have appeared in the daily papers and in one of the Toronto magazines. Such results have, of course, not been obtained without effort on the part of the Institute and we owe much to our Publicity Committee for their splendid work. It is difficult to express properly what is due Mrs. Arnold C. Matthews, Chairman of the Committee, for the role she has played in this matter. Her retirement from the Council this year will be a real loss to the Institute.

The Saturday morning Press Conference, at which our speakers meet representatives of the press, again proved very successful. Professor T. F. McIlwraith, who was in charge of the Conference, managed this in an excellent manner. Only one speaker failed to attend and he did not arrive in the city before Saturday afternoon.

Membership shows a gratifying increase, with 265 new members enrolled this year, making a total membership of all classes of 1735. This is an overall increase of 128. One very pleasing feature was the large number of persons who of their own volition sought membership in the Institute. There were 117 resignations, 47 more than in the previous year, but our records show an unusually large number of paid-up members.

Great credit is due the Membership Committee of which Dr. V. B. Meen was Chairman and Mr. C. F. Publow, Vice-Chairman, for their fine efforts in securing new members. We would also be neglecting a great obligation if cognizance were not taken of the remarkable zeal shown by our veteran solicitor of members, Mr. George C. Gale. He has never failed to find new fields for canvassing or to bring in a large number of new members, especially from companies located in the city.

It is with great regret that we must record the death of twenty-five of our members, six more than for last year. Among these was Professor Joseph Ellis Thomson, a Past-President and Honorary Member. Professor Thomson was one of our most active members, and he served on the Council for a total of fourteen years, filling the positions of Councillor, Honorary Secretary, Vice-President, and President. He made a notable contribution to our society and in his death it has suffered a great loss.

The publication of the Transactions is a very important function of the Institute. They serve as a medium for the printing of scientific articles and as a means of securing exchanges with other organizations. That they are valued highly is indicated by the large number of exchanges we have in many parts of the world, and the requests for the privilege of purchasing back numbers coming from libraries in Canada and beyond her borders. They contain valuable articles mainly on the natural history of this country. It is suggested that the scope of the Transactions might be broadened somewhat to include other fields of much importance in the development of our country.

Volume 25, Part 2, of the Transactions was published during the year, as well as Volume IX, Series IIIA, of the Proceedings. The Institute is deeply indebted to Dr. E. M. Walker, our Honorary Editor, who now retires from his onerous duties after twenty-one years service in that capacity. He has, with great care and attention to details, maintained a high standard in our publications.

The library is, in many respects, the Institute's greatest asset although not at present providing nearly the service which it could provide under more favourable conditions. The situation to-day is not very different from that described in the President's report a year ago. The library contains over 33,000 publications, some of which are not available elsewhere in Canada. Some serial publications extend back to 1828. About two thirds of the volumes are available to readers in the University of Toronto Library, a large number are in dead storage in the basement of University College, and the remainder are at the Institute headquarters. There were 380 accessions during the year. Because of the war great difficulty has been experienced in getting binding done, in securing trained assistants for care of the books, and in securing regular foreign exchanges. The Council has therefore been setting aside considerable funds to take care of these items as soon as the war is over. The Province makes an annual grant to the Institute for the support of the library, and we greatly appreciate a marked increase in it for the year. It is an interesting fact that eight new exchanges were established, one in Lisbon, and seven in South American countries. We are thus helping to form bonds with the peoples far to the south.

The future of the library is a problem of much importance and the Council has been making great efforts to solve it. It is wrapped up with that of securing new headquarters, a matter which will later be discussed. Dr. E. Horne Craigie has served the Institute very capably as Honorary Librarian for ten years, and he is retiring from that position. Our sincere thanks are due to him for all the thought and labor expended on the library during those years.

The Centennial Committee, under the chairmanship of Mr. Wills Maclachlan, has been active during the year. This committee was appointed in 1942 to make plans for the fitting observance of the one-hundredth anniversary of the founding of the Institute, and plans are maturing for that important event.

The matter of securing new headquarters for our society has given the Council much concern. The University has given notice that our present quarters must be vacated in time to permit the erection of a large university building on that site. Work is to commence on this building at the close of the war.

The Council appointed a special committee, known as the New Quarters Committee, with Dean G. G. Cosens as Chairman, to canvass the building situation in the vicinity of the University. The Committee obtained much valuable information regarding available premises, their suitability for our purposes, and their costs. This information has been laid before Council and carefully considered.

There are many matters involved in selecting a new site. It should be centrally located, preferably in the vicinity of the University because our lectures are held in Convocation Hall and because the close relations of the Institute and University are a great advantage to both. Our library can render its greatest service to faculty and students of the University.

It does not seem possible at this time to secure any space on the campus because of the crowded conditions in the University. This leaves three possibilities: to purchase an existing building and remodel it to house the offices and library; to buy a lot and build a building for our own use; or to join with a group of other societies which have been discussing the feasibility of constructing a large building which might serve as a centre for most of the scientific, engineering, and other Toronto societies needing space. In many respects, the last would be a most desirable arrangement but it will no doubt take a long time to organize such a project and secure funds for it. There is also the problem of management of such a large project. The Institute should never become involved in any scheme that would overtax its financial resources and make its operation a heavy financial burden on those responsible for its direction. It should, however, endeavour to give leadership in projects that will advance our scientific and technological societies, because it, in a sense, is related to all of them and it is the oldest society. It is ready and willing to co-operate with the other societies in the city if a practical solution can be found for a project providing a scientific and technological centre for a number of societies. In the meantime, however, it is imperative that some steps be taken to provide new headquarters and the Council has decided to purchase a building near our present site and remodel it to suit our needs. It is strongly felt that provision must be made in new quarters to house our library properly and to make it function in an efficient way.

The finances of the Institute are in a very satisfactory condition and the year ends with a credit balance. Our total income for the year, including a Provincial grant of $1,000 in support of the library, amounted to approximately $10,800 and the expenditures to nearly $9,800. Income and expenditures were somewhat higher than last year. The expenditures included a sum placed in reserve to do things for the library when the war ends which can not be done during the war. The publications cost $1,226.46. A Reserve for Contingencies Fund has also been set up to provide for part of the unusual expenses that must be taken care of in moving to new quarters. At the suggestion of our auditors, the Finance Committee, under the able leadership of Mr. John S. Dickson, has recommended that certain capital funds be consolidated so that they will be more conveniently administered. Steps have been taken to bring this about by changing the Regulations after securing the advice of our Legal and Property Committee. There was some decrease in current income resulting in a decrease in interest through conversion of certain bonds at a premium, with an increase in capital account.

The books of the Institute have again been audited by Mr. H. Frank Vigeon and Mr. C. Watson Sime, chartered accountants, who have generously performed this work and supplied a certificate that the accounts are correct. Any member wishing to examine the accounts may do so by calling at the office.

Your Council held seven meetings during the year for the transaction of the business of the organization. Six members of Council retire this year: Dean G. G. Cosens, First Vice-President; Surgeon Captain C. H. Best, Second Vice-President; Professor L. Joslyn Rogers, a Past President; Dr. E. M. Walker, Editor; Mrs. Arnold C. Matthews; and Group Captain S. N. F. Chant. Their services have been of great value and they leave the Council, but we hope not service to the Institute, with our gratitude for what they accomplished during their tenure of office.

This report woud not be complete without an expression on behalf of the members, of appreciation of the efficient and faithful service rendered to the Institute by Mrs. Florence C. Rawlings, formerly Acting Secretary-Treasurer, now our Executive Secretary. Mr. D. Bruce Murray is also entitled to receive our warmest thanks for his unfailing help in many kinds of emergencies.

In closing, I want to take this opportunity of thanking, on my own behalf, our members, and members of Council for the very loyal support given me during a strenuous year. Further, the manner in which Mrs. Rawlings, assisted by Miss Styles, took care, in such a cheerful manner, of the innumerable details involved in the operation of our society, merits my sincere gratitude.

E. S. MOORE,
President.

The Saturday Evening Lectures

One of the objects of the Royal Canadian Institute is to further a popular interest in research. Since the results of research are so far-reaching in their effect upon the life of every member of the community, it is necesary to create an intelligent public who will be able to follow the work and achievements of those who are engaged in it.

What has been done in the past is illustrated by such important accomplishments as the invention of the telephone and the radio, the discovery of radium, the improvement of the telescope, also by the immense access of knowledge as to the structure of matter, whether in the atom or the universe, the manifold phases of life on the earth, and the exploration of the world.

The lectures of the Institute are the medium whereby such work is explained to the public. On Saturday evenings during the season, popular lectures of a scientific nature are given by men outstanding in their own field. The purpose is to interpret scientific research for the public.

"Ontario Through Two Billion Years"*

E. S. MOORE, M.A., Ph.D., F.R.S.C.

Head of the Department of Geology, University of Toronto, and Director of the Royal Ontario Museum of Geology.

PRESIDENTIAL ADDRESS.

October 28th, 1944.

INTRODUCTION

Please do not be alarmed by this title. I just wanted plenty of scope for my talk. I do not intend to discuss each year of this province's geological history, only some of the major events that have been responsible for shaping Ontario as we find it to-day.

The distribution of our industries and population is partly due to climatic conditions but mainly to the results of geological processes operating through eons of time.

The question will naturally be asked: Why two billion years? This is considered to be about the time that has elapsed since the first rocks in northern Ontario were formed; the time when Ontario, and in fact the North American continent, began to exist as an entity emerging from the unknown state of affairs that had previously existed.

GEOLOGICAL TIME

We do not know that it has been just two billion years since our first rocks in Ontario were formed. Geologists are generous with time since they know there is plenty of it, so a million years or so is not vital in such a time scale. We have to depend upon the physicists for some of our figures, and since they work with instruments of precision, and are usually mathematically correct, we accept their results. These results are based on the study of radio-active substances in the rocks. Certain minerals break down slowly in the rocks of the earth's crust giving off radium emanations at a fixed rate and produce certain elements as a residue. Take the mineral uraninite for example. It gives off radium emanations and lead is produced. By analyzing the quantity of lead produced, and knowing the rate at which it is formed, the length of time required can be calculated. The results would be very accurate were it not for the fact that nature's laboratory is quite unlike that of the physicist where everything is under control. In nature's laboratory things get lost through disturbances that affects the rocks from time to time, and all the products of

* Illustrated with lantern slides.

radio-activity may not have been preserved for the analyst. It would appear that these age determinations must therefore be the minimum possible age rather than the maximum.

In any case the physicist's age determinations suit the geologist quite well because immense periods of time are required to accomplish many pieces of geological work that we know have been done. Take the time necessary to wear down almost to sea level a great range of mountains, like our Rockies. Few people can visualize the slowness and relentlessness of geological operations. A Toronto school teacher told her class that glaciers do not move. She said she knew that because she one day sat watching one.

A relief model of eastern Pennsylvania shows the finest example in the world of a great mountain system, probably as high or higher than the Rockies, worn down almost to sea level and then slightly uplifted again. One can see the stumps of the once great ranges at nearly uniform level. The time to do this work must have been very long. In northern Ontario, we have good evidence that great mountain chains were uplifted and worn down, not only once but three times, possibly more. We find their old stumps.

Divisions in Ontario

If we look at a geological map of Ontario we shall see that it can be divided into about three main divisions so far as rocks are concerned. It is also evident that there are two main divisions, one for agriculture and one for mining. The population, agriculture, and manufacturing are found mainly in the south and the mining is nearly all in the northern part of the Province. This division of things is the outcome of events that began very early in the geological history of the Province.

Northern Ontario

The northern part of Ontario is underlain mainly by very old rocks which we call Precambrian because they were formed in the Precambrian era. It is a rough, hilly, and rocky land. There are no mountains although such existed at one time on a large scale. It has more lakes for its size than any other country in the world. These lakes are, however, a very late feature to be developed, being the result of glaciation. They add great beauty to the landscape but, like cosmetics, they are only on the surface and of temporary character. Rain and frost will, geologically speaking, soon remove them.

Northern Ontario is in the Canadian Shield which occupies just about half of all Canada. It is a valuable source of metals but it does not contain any coal, oil, natural gas, salt, or gypsum. The soil is thin or poor except where the large lakes, following glaciation at a very late period, spread muds over the bare rocks.

A view of northern Ontario from an airplane at a high level shows a great area with innumerable lakes, hills, and valleys. None of the hills are very high, a few hundred feet above the lakes, and the whole area gives the impression of being a rough plain. Closer investigation shows that this has been an area of numerous and large volcanoes. Scenes similar to those in New Zealand and Hawaii, areas of recent volcanic activity, were very common, but the cones have all been removed by erosion. Great fissures opened up in the earth's crust and immense lava fields of red-hot rock escaped from them. It was a fiery land during more than one period in its history, but strange to say there were alternating periods when even glaciers spread over the surface.

It is quite a legitimate question to ask how we know that such conditions existed when everything in the region now gives the impression of endless stability. A great mass of volcanic dust and rock fragments was hurled from Mt. Tarawara, New Zealand, in 1886, and the material was spread over a large area, destroying nearly everything in its wake. It consists of fine dust and larger fragments of rock, formerly solid, that have been blown to bits by a great explosion. Such material becomes cemented into solid rock. The finer material forms what geologists call tuff, and the larger fragments, agglomerate, a rock consisting of angular fragments of all sizes jumbled together. We find thousands of feet of similar rocks in northern Ontario, formed in the earliest days of its geological history. An aerial photograph of an area surrounding the Helen iron mine, on which I worked last summer, shows such materials in great thickness. The lighter-coloured rocks are tuff and agglomerate, indicating the enormous amount of material hurled from volcanoes in the earliest days. One hill consists of volcanic material, some of it worked over by water, and close examination shows the rocks to have characters like those of rocks around modern volcanoes.

The great lava fields are just as evident as the other volcanic features described. Standing on a hill in the Island of Hawaii a few years ago, I was strongly impressed by the similarity in the contour of some of the recent lava fields near the active volcano, Kilauea, and some of the most ancient lavas in northern Ontario. Only the Ontario lavas were green with age and the fresh ones from Kilauea dark grey or brown.

All the Ontario volcanoes are dead and lifeless. None has operated for half a billion years. Sometimes it seems a pity that we could not have kept one or two in operation so that our students could see just how the old volcanoes worked. They are, however, treacherous things to have around, as you never know what they will do next and you will see a good example of this in one of our later lectures in the series. I was walking around inside the crater of Ngauruhoe, in New Zealand, one Saturday

afternoon when it seemed quite friendly, but it blew out with an explosion on Monday morning.

Ore Deposits

The northern part of Ontario is a great metal-mining region. This is because our ores originate in igneous rocks, that is, rocks that have been melted, or dissolved, because of great heat. Ore deposits, except those due to weathering of igneous rocks, such as gold placers and some iron deposits, do not originate in sedimentary rocks such as those found in southern Ontario or in the prairies.

We will try to illustrate how our gold veins, for example, were formed. It is a complicated chemical process and, of course, no one has been down there to see the performance. We believe that they have formed from large masses of hot liquid rock; like granite. We can think of these intrusions of granite in the liquid state as great bodies of solution with minute quantities of gold scattered all through them. The body begins to crystallize around the cooler border, and the ordinary minerals of granite are formed. The gold does not crystallize with these minerals but it is kept in solution by such substances as sulphur, sodium, potassium, etc. One can liken the operation somewhat to a solution of salt water in a vessel subjected to a very low temperature. Ice begins to form around the inner side of the vessel but the salt in solution does not enter the ice. The solution grows richer in salt. In somewhat the same way the gold is left in solution in the liquid granite as the mass is cooling, and the proportion of gold increases.

Just before the granite all becomes solid, the small amount of gold-bearing solution is forced outward into the overlying rocks to form the gold veins. A considerable amount of quartz goes along with the gold to form the gangue in the veins. The veins are formed away below the surface of the earth, in some cases several miles in depth, so it is only after thousands of feet of overlying rock have been removed by erosion that the veins are exposed to the prospector.

What we call the Algoman period was one of great importance to Ontario because over 95 per cent of our best gold veins were formed from the granites and related rocks intruded in that period.

Another event of great importance occurred in the Keweenawan period, much later than the Algoman, when the Sudbury nickel intrusive was formed. This is well illustrated by a relief map of the Sudbury area in the Royal Ontario Museum of Geology. The intrusive is about 37 miles long by 17 miles wide and around its border are arranged the famous ore deposits. During the war this wonderful area has been producing over 80 per cent of the world's nickel, so important in ordnance, armour plate,

munitions materials, and for numerous other purposes. It is the world's largest producer of platinum and palladium, Canada's largest source of copper, and it also produces considerable gold and silver as by-products. One of the New York technical journals recently pointed out that Sudbury was one of about half a dozen mining camps in the world that had produced over a billion dollars worth of metals, and the end of the ores in this camp is still in the distant future. It is a remarkable example of the importance that one great geological event may be to our province, and to the world.

Mountain Building

We know that large mountains were built in Ontario during several geological periods. We may try to envisage from a diagrammatic illustration how the sediments and lavas were folded up into mountains, probably as high as our Rockies. Experience has shown that large masses of hot, liquid granite tend to crawl up beneath the folds as they are heaved up. When the ridges are eroded down, a nearly flat, rough surface is left and the great masses of granite are exposed. This is an explanation of the occurrence of the great areas of granite with narrow masses of other rocks between them such as we find in Muskoka, Haliburton, and other parts of Ontario. It is in the small areas of other rocks that we find most of our ore deposits.

Earthquakes

Ontario, in Precambrian time, must have been an area of violent earthquakes with all its volcanoes, mountain building, and faulting. There are faults over 100 miles in length. It has, however, settled down to enjoy a quiet old age with only an occasional minor quake around the borders of the Shield, such as the recent one at Cornwall. B. Gutenberg, an authority on earthquakes, says the Canadian Shield is one of the least seismic areas in the world.

Close of the Precambrian

With the close of the Precambrian, there were no rocks anywhere in the Province, even in the southern part, but those of that age. Three quarters of its life had been spent, one might say, in almost riotous living. It had been reduced by hundreds of millions of years of erosion to a roughly plane area that is known as peneplain. There is a false impression in the minds of a great many people that the reduction of the ancient mountains was due mainly to the Pleistocene glaciers. They had relatively little to do with it, as the mountains were reduced a half billion years before the glaciers arrived. Rain, running water, and frost action were the main agents of erosion.

Invasion by Palaeozoic Seas

Ontario, not much above sea level, sank enough in Cambrian time for the ocean to invade it. During the next 200,000,000 years the Palaeozoic seas flooded practically all of this province. The seas were not very deep and they came on and retreated several times, as the level of the land oscillated up and down. They were not necessarily over the same parts of the Province each time.

In these seas gravel, sand, and mud were washed in to make our sedimentary rocks, and innumerable marine animals left their shells to form the limestones which now underlie southern Ontario. These rocks were then much more widespread than now, as great quantities of the sediments have been eroded from the thin mantle that once spread over the Precambrian rocks. One can say that if Ontario were raised high enough above the sea for sufficiently long all of these Palaeozoic rocks ultimately would be removed and we would have nothing in the Province but Precambrian rocks, like those in northern and eastern Ontario. They lie under Toronto at a depth of about 1,100 feet. The Palaeozoic sediments were laid down nearly flat and they have remained nearly so ever since. No volcanoes nor mountain building have troubled the Province since the end of Precambrian time, although there has been considerable faulting in the eastern section, south of Ottawa.

During part of the Silurian period the southwestern part of Ontario was mainly desert and our valuable salt and gypsum deposits were formed in arms of the sea and salt lakes. The sediments became so saturated with salt that we can not get any fresh water by drilling into the solid rocks over large sections of southwestern Ontario.

The question is often asked: Why do we not have coal in these sedimentary rocks in southern Ontario? It is because they were formed before the land plants, responsible for our coal, appeared on the earth in sufficient quantity to make coal.

Niagara Escarpment

The Palaeozoic seas finally withdrew to their proper place in the ocean basins and most of Ontario has been subject to erosion for about 300,000,000 years. One very interesting topographic feature has developed in its southern part. This is the Niagara Escarpment or *Cuesta,* which means an escarpment resulting from long erosion. The cuesta is known in different places as the Grimsby Mountain, the Hamilton Mountain, and the Collingwood Mountain. It is known as the pride of Hamiltonians but I would like to point out that we seem to have had it at Toronto at one stage. We found it in the way of expansion of a large city and passed it on to Hamilton. It is unquestionably moving slowly westward. It seems to have started in eastern Ontario and worked as far west as its present position.

The Niagara River has cut a salient 7 miles deep in the escarpment. It is estimated that it has required about 25,000 to 30,000 years for the Niagara River to cut this gorge and if it has required the concentrated flow of this river that length of time to cut seven miles, it will be a long time before the escarpment will reach Kitchener or London. If things remain stable, it will, however ultimately reach the shore of Lake Huron. In the meantime, the Niagara River will have drained Lake Erie and there will be a valley coming around to the south end of Lake Huron.

The escarpment exists for the same reason that Niagara Falls do. A heavy layer of dolomite at the top partially protects the underlying softer rocks which weather away and allow large blocks to fall from the top of the cliff, and thus a vertical face is maintained. One can often see these blocks of dolomite lying along the foot of the escarpment like those at the foot of the American Falls at Niagara.

Pleistocene Glaciation

Previous to the advent of Pleistocene glaciation, Ontario had been subject to erosion for perhaps 300,000,000 years. There were no invasions of the sea, unless it be for a small area around James Bay. A great river, called the Laurentian River, drained the basins now occupied by the Great Lakes which had not yet come into existence. There were probably almost no lakes in northern Ontario. The whole province was undoubtedly covered with soils, those in the north not as fertile as those in the south, and the latter not as fertile as they are now. Photographs kindly supplied by Mr. H. S. Scott who recently worked in Greenland, give some idea of conditions in Ontario in the Pleistocene epoch.

Then came the glaciers, and their effects on the present situation in the Province have been profound. Time does not permit an extensive discussion of the effects of galciation. In any case they are more or less familiar to you.

The formation through glacial action of the Great Lakes, the finest chain of fresh-water lakes in the world, provided water for our cities and towns and an unsurpassed inland waterway for navigation. These great storage basins and their associated rivers provide our water powers for hydro-electric development which has added very greatly to our standard of living.

The great proglacial lakes played an important role in our agriculture because the mud and silt deposited in them covered up the Precambrian rocks over large areas and made level, fertile lands where formerly only rocky Precambrian areas existed. Examples may be seen along the north shore of Lake Huron between Sault Ste. Marie and Sudbury, and in the large "Clay Belt" of northern Ontario.

Unfortunately, the glaciers destroyed placer gold deposits, and the sediments in the proglacial lakes probably buried numbers of mineral deposits in northern Ontario, but, on the other hand, the ice scraped many rock ledges bare so the prospector can see ore deposits formerly covered by a layer of weathered material.

Glaciation greatly benefitted agriculture in southern Ontario by spreading a layer of glacial drift over it. This forms soil of good texture and that containing plant-food ingredients, such as potash, lime, and phosphate which occur in the ground-up rocks comprising the finer materials in the glacial drift. These soils leach slowly and the weathering of the small particles of freshly broken rock furnishes a fresh supply of plant food.

There is one aspect of the water-power situation I might mention. Our neighbours in the State of Illinois have claimed the right to divert water from Lake Michigan to the Mississippi for power and sanitary purposes. Some have claimed this right because the water once flowed in that direction. It is very dangerous to start meddling with nature's arrangement of things because it could be shown that at a later period most of the water went across Ontario by way of Lake Nipissing and the Ottawa River, leaving Illinois out entrely. At an earlier period it travelled by way of the Laurentian River.

THE FUTURE

Will the glaciers come back again in a short time? We know they invaded Ontario four times during the Pleistocene epoch and melted away. Between the invasions there were some interglacial stages when the temperature averaged higher here than it does to-day. The glaciers in the mountains of the West and the Greenland ice-cap are still retreating. This indicates a gradual warming up, but whether it is a permanent thing for some millions of years it is difficult to say. There recently appeared in one of the magazines a conversation between a tourist and a New England farmer in this wise. The tourist asked the farmer where all the loose rocks lying around came from. The farmer replied that the glacier brought them. The tourist asked where the glacier is now. The farmer was ready with "gone back for more rocks." There may just be more truth than fiction in that statement.

"Wings West from Florida"

JOHN H. STORER, A.B.

Waltham, Massachusetts.

November 4th, 1944.

An all-colour motion picture, much of it in slow motion, illustrating the principles of bird flight, was shown at this lecture.

It was explained that the main purpose of the film was, by means of spectacular pictures of birds, to draw attention to the dependence of all life, including our own, on a healthy condition of the land. The widespread destruction of farm and forest land has brought many forms of life to the verge of extinction and caused untold economic damage to man.

The film was taken during 18,000 miles of travel from Florida to Texas, Washington State, and Maine, and included many pictures taken on sanctuaries of the National Audubon Society and the United States Fish and Wildlife Service.

Among the beautiful scenes in this film are white ibis in flight, American egrets displaying nuptial plumes, an unusual home situation of the Florida jay, with three birds taking care of one family of young. Scenes in Texas show the roseate spoonbill and white pelican sanctuaries. Steelhead trout leaping steep waterfalls, and living pictures of flowers opening are also included.

Slow motion close-ups reveal the mechanics of bird flight. Mr. Storer pointed out that birds and airplanes are built along much the same lines and function on the same principles, but that planes fly so much faster than birds that they meet some problems in aerodynamics that the birds do not have.

The inner half of a bird's wing moves very little during flight. It is always held at about the same angle to the line of flight, and functions like the wing on an airplane, to support the bird as it slices forward through the air.

The outer half of the wing, from the wrist out, works on an entirely different principle. It is so constructed that, on the down stroke, the pressure against the air twists it into the shape and angle of a propeller blade. The air then drives it forward, pulling the bird along after it. The individual primary feathers at the wing tip are twisted in the same way to become small propellers during the down stroke. As they spread

apart the slots between them play a vital part in giving the wing a better grip on the air.

Some birds can rise vertically like a helicopter, using a horizontal motion of the outer, propeller half of the wing, so as to direct its driving power upward like the rotor of a helicopter. Some can also fly backward by a slight change in the angle of the propellers. This was demonstrated by a pair of snowy egrets fighting in the air. A humming bird is one of the best known examples of a bird that can fly backward, as it often does to withdraw its bill from a flower.

"Scientists at War"

SIR ROBERT WATSON-WATT, C.B., L.L.D., D.Sc., F.R.S.

Scientific Adviser to the Air Ministry (London) on Telecommunications, and Vice-Controller of Communications Equipment, Ministry of Aircraft Production.

November 11th, 1944.

The experience of scientists in the present war illustrates failures in certain respects to bring science into its proper place in the community in the years before the war. From this experience also can be drawn lessons for the wider application of science to the problems of the nations in the postwar world.

For its most useful practical application, science must be strengthened from that fountain of exact knowledge which springs from the long-range academic search to discover how everything works. The foundation of science at war was laid in the universities. For instance, radar was a child of "useless" studies; it was not the product of the study of specific military problems. It resulted from the piecing together for practical application of the work of many people pursuing exact knowledge in their own special and limited fields. Had we set out from the beginning to find a practical solution of the radar problem we should have made a bad job of it if we had not first proceeded through pure science.

Institutions devoted exclusively to the application of science to war were not outstandingly successful for two principal reasons. The personnel was so closely devoted to immediate problems it had lost some of the sustenance of academic science. It was also insufficiently in contact with the operational problems in the field, with the solution of which it was called upon to deal. In order to find out to what problems scientific method could most profitably be applied, scientists should have been

brought more closely into the military, naval, and air councils, to conduct studies in "operational research."

While the well-spring of useful science is the academic search for exact knowledge, the result of taking so many scientists from their sheltered laboratories to pursue war work cannot be other than good. Their experience should make them better statesmen of science and project its effect into the arts of peace.

Transplantation is part of the stimulus to full growth and in the postwar world a parallel to this principle could be applied to the place of scientists in the community at large. The needs of the nation in many cases must be brought to the laboratory for solutions; conversely, scientists must leave the universities to understand the background of those problems as well as to gather them in for fundamental study. Such academic scientists should be taken into the policy councils of the state and industry and turn their attention to the basic elements in problems which are important in everyday living. They should sit within the councils of the nation as maintainers of health rather than be summoned as physicians from without, when the diseases are far advanced. We believe we have preventive measures that are more important and effective than curative ones.

"Parícutin, Mexico's Newest Volcano"

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November 18th, 1944.

Near Parícutin, Mexico, a volcano was "born" in February, 1943. It offered the first opportunity in nearly two hundred years to observe the development of a volcano from its beginning. The last new volcano appeared in 1759 and erupted for nineteen years. It also was in this area which is about 200 miles from Mexico City where the countryside is dotted with extinct craters, many of them so old they are overgrown with vegetation and forests.

The party from the American Museum of Natural History reached the volcano about three months after its first appearance and took coloured moving pictures of its many aspects. Another group returned in March, 1944, and found the town of Parícutin completely obliterated and the nearby town of San Juan threatened. The cone, which is caused by the piling

up of material ejected from the crater, had reached a height of 1,350 feet and was still growing. The dust column was 30,000 feet high.

Capped by a plume of water vapour and showing at its base at night a brilliant glow of red and orange colours reflected from the incandescent rock in the crater, this column of ash dust is the most impressive aspect of the volcano. It is also the most destructive. It fell heavily over a radius of 20 miles, giving the surrounding country the appearance of a winter scene. It killed all trees and other vegetation that came under its blight and buried the town of Parícutin in ash which was later overlaid by a thick layer of lava. So thick was the blowing ash dust it was often impossible to see a man 20 feet away.

The sound of the volcano is somewhat like the roar of heavy surf, caused by the explosions in the crater, punctuated by a rattling noise from the tumbling of the "bombs" which are fragments of the solidified lava thrown out of the crater and rolling down the sides of the cone. A sudden cessation of the roar was caused by a rupture of the cone, and at the base of the terrace, so formed, a new lava flow emerged. From other vents the lava flowed in thin pulsating streams that measured as much as 8 feet thick, and extended for miles. The fluid flows near the vents soon give way to the thicker slowly-advancing plastic lava which advances for miles.

Another expedition is leaving for the scene and it is hoped that sound effects of the volcano's eruptions may be recorded. Analysis is also being made of the gases which may throw some further light on the disaster of the Mount Pele eruption in the last century.

"The Ancient and the New in Chinese Medicine"

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November 25th, 1944.

China's ancient system of medicine is closely related to her ideas of the nature of the universe. Health was supposed to be due to a balance between the two cosmic forces, the *Yang* and the *Yin,* and among the five elements: metal, wood, water, fire, earth. Any imbalance caused disease. The cosmic forces are represented in the body of man by the higher or intellectual spirit, the *shen,* derived from the *Yang,* and the lower or animal spirit, the *kwei,* derived from the *Yin.* At death these separate, the former returning to its source upwards, and the latter to the earth.

Chinese ideas of anatomy were elementary, practically no dissection having been carried on. Physiological theories were entirely speculative, and had no experimental basis. Some of these speculations came relatively close to the truth, such as the idea that the blood was in continuous circulation. But they had no true conception of the function of the heart or of the difference between arteries and veins.

Diagnosis was largely by means of the pulse. Peculiar ideas were held regarding ability to diagnose the conditions of various organs from feeling the pulse in different locations or with different degrees of pressure.

Beliefs in demonic possession were also common, and hence exorcism became a recognized form of treatment. The Taoist cult had considerable influence in this regard. Taoists also sought the elixir of immortality, and introduced various methods of deep breathing to produce health. Buddhism also stressed devils and demons as causes of disease, and hence advocated their expulsion by means of incantations and charms.

Treatment by acupuncture was also common, as was cauterization by burning moxa on the skin. Various forms of counter-irritation and massage were also practised.

Drug treatment included a host of remedies, some valueless, some now known to be valuable therapeutic agents, and many as yet not investigated scientifically. Extensive pharmacopoeias have been published, some dating back many centuries.

Although Chinese medicine has come too late into the stream of the world knowledge to have exerted much influence upon modern medicine, nevertheless, from the historical point of view it cannot be neglected. Some of her early medical observers were very careful recorders of diseases and their symptoms, and at least one has frequently been compared to Hippocrates. Chang Chung-ching's "Essay on Typhoid" is deservedly recognized as one of the world's medical classics.

Scientific medicine was introduced into China about 110 years ago by Christian missionaries, and its development in China has been largely due to their efforts. Hospitals, medical schools, schools of nursing, of dentistry, of pharmacy, and of hospital technology have been developed under Christian auspices. Also a medical literature has been created by the translation of books into Chinese. The same group was responsible for the organization of the medical profession, as it developed in China, into a nationally recognized society.

Under the influence of the newly developed medical profession the Chinese Government created the National Health Administration in 1928,

and this organization is now officially responsible for the nation's health. It has adopted State Medicine as the official programme of national health. China's health problems make this method the only possible one for any early solution.

The greatest problem at the present time is a lack of a sufficiently large number of trained personnel. There is about the same number of qualified medical doctors in China as in Canada, but whereas this provides one doctor for approximately 1,000 persons in Canada, there is only one for every 40,000 persons in China. China has only about one fifth as many nurses as Canada. One result of this terrible shortage has been that China's wounded soldiers and civilians injured in the bombing of her cities have had very inadequate care. Attempts to supply the need by short training courses have not proved too successful.

Under the state medicine programme China plans the training of very large numbers of physicians, nurses, dentists, etc. Only by radical departures from the usually accepted methods of education can these numbers be trained in a reasonable time. Assistance to China in her training programme would be most acceptable. In the past such assistance has been forthcoming from the Christian churches, the Rockfeller Foundation, and a few other international organizations interested in health. Canada has shared in this, particularly through her work in mission hospitals and in mission supported medical schools. Possibly more effective support should yet be given, for China's health problem is one of international as well as national importance.

"Electronics, Television, and Frequency Modulation Radio"

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December 2nd, 1944.

Electrons are those minute particles which revolve in their tiny orbits in the atom. Confined in vacuum tubes similar to those in radios they can be controlled to an exactitude undreamed of in mechanical things. In this way through the science of electronics the engineer now has hold of electricity itself rather than just its manifestations and to its uses there is no end in sight.

The electron is only one billionth the size of a pin point but by its use nearly all human senses have been extended far beyond the limits set

by nature. It can be used to detect flaws in steel twelve inches thick, the scent of poisonous vapours or traces of flavour imperceptible to the senses of smell or taste. The electron microscope magnifies many times beyond the range of optical instruments. Electronics has at its command the speed of light—186,000 miles per second; its operation involves no moving parts and its apparatus does not require heavy foundations. Since the beginning of the war electronic engineers have learned to handle frequencies of more than 3,000 cycles per second. In this field of high frequencies are most of the wonders of war equipment in the development of which a great scientific battle had been waged between the scientists of the Allies and those of the Axis. The most important phase of this battle has been "seeing electrically" in which radar was the most conspicuous development. Electronics now goes to war with airplane and submarine detectors, gunfire control systems, communications between planes in the air, tanks on the ground, ships at sea, and portables for quick control of vast numbers of fighting men and units of equipment. It is hard to set limits to its peacetime applications and these will definitely include devices for safety of travel by air or sea.

Frequency modulation in radio will be available directly after the war and television may not be many years later. In the United States there are now fifty FM broadcasters and half a million FM receivers. Under the present amplitude or AM modulation radio, sound is transmitted on "carrier waves" and regulated by increased or decreased power. In frequency modulation the power is kept constant and the sound is regulated by changes in frequency. This eliminates all interference and distortion, maintains the same strength day and night, and increases the range of pitch. Because FM broadcasting is limited approximately to the horizon or about 50 miles, it may vastly increase the number of stations by permitting many to use the same wave lengths without interference.

Greater difficulties are faced in the development of television which is perhaps ten times as complex and ten times as costly as broadcasting sound. For instance, still pictures can now be sent across the Atlantic by wireless in two minutes; but television will require a broadcast of thirty pictures a second. There are at present seven or eight television broadcasting stations in use in the United States and several thousand receivers.

"Plant Life in a Botanical Garden"

WILLIAM J. ROBBINS, A.B., Ph.D., Sc.D.

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December 9th, 1944.

The New York Botanical Garden was established in 1895, and occupies about 230 acres in Bronx Park, about seven miles from the centre of the city. It provides outdoor displays from April through November and indoor displays in a conservatory that covers more than an acre of ground. In addition to these attractions for the general public it does important research work in botany and its expeditions have brought back many new species from foreign countries.

The displays are enjoyed by more than a million people every year, as many as 15,000 sometimes coming on a fine Sunday in spring to see the rock garden, borders, and indoor displays. In addition to these it has attractive natural scenery which includes 40 acres of native hemlock forest bordering the picturesque gorge of the Bronx River with several miles of surfaced paths.

Included in the rock garden displays are a fine collection of flowering shrubs and trees; 2,500 kinds of rock-garden plants in an enclosed rock-garden of 3½ acres; flowering meadow and wild garden; 300 kinds of irises; 700 varieties of roses as well as annuals, perennials, daylilies, peonies, waterlilies, herbs, asters, dahlias, and chrysanthemums. There is also a demonstration back-yard vegetable garden from which a ton of food was harvested last year.

There are fifteen separate greenhouses or units in the conservatory, which include palms that tower towards the ninety-foot dome of the central building. One of the largest collections of begonias in the country has a house to itself as have geraniums. More than 1,500 kinds of cacti, among them many varieties, occupy three houses where they are planted out as though in their native deserts. Aquatic plants, including the famous Victoria waterlily from South America, flourish in an indoor pool. There is also a simulated tropical rain forest, curtained by the aerial roots of jungle vines. In the Tropical Flower Garden trees, shrubs, vines, and flowering herbaceous plants are effectively arranged for year-round enjoyment. From November until May in the conservatory is presented a continuous series of flower displays with all the plants set out as though in a garden.

Classes in practical gardening and in various branches of botany are held. In the field of research the botanists at the Garden have identified and written the official descriptions of more than 5,500 plants or more than 1 in 70 of all the plants now known. Most of these have been brought back from the Garden's own expeditions. Thus, one of the major scientific functions of the New York Botanical Garden is the extension of man's knowledge of the kinds of plants. It also does important research in plant physiology, in the diseases of plants and their control, and in genetics, both of fungi and of flowering plants.

"The Rubber and Tire Situation—Present and Future"

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December 16th, 1944.

Soon after the Japanese attacked in the Pacific they had gained control of 92 per cent of the rubber-producing areas of the world, and the United Nations, caught with a limited stockpile of rubber, narrowly averted disaster. That they did avert disaster was due to drastic restrictions of the use of rubber in the stockpile and the fortunate fact that the petroleum, chemical, and rubber industries had some information about the manufacture and use of synthetic rubber. Although this information and experience was meagre, by one of the greatest co-operative efforts in industrial history a new synthetic rubber industry was conceived, built, and put into full production in two and a half years.

In addition the industry had to perform the almost impossible task of learning how to use this new chemical rubber to make satisfactory products with the existing equipment. The critical controlling factors of raw materials, manufacturing capacity, and manpower have been adjusted to such good effect that so far as the supply of synthetic rubber is concerned we shall now have more available than the United States and Canadian pre-war consumption of natural rubber.

But for many products, especially tires, synthetic rubber cannot wholly take the place of natural rubber of which there is still a shortage. In thick, heavy tires one of the basic deficiencies of synthetic rubber is the high temperatures generated. For this reason it is not yet possible to make large-size truck tires out of all synthetic rubber, thirty per cent of natural rubber being necessary to prevent excessive development of heat.

The all synthetic passenger car tire has been giving a good account of itself when used at war-time regulations of speed, although at high speeds it also shows the same deficiency of high heat build-up.

In meeting the progressively increasing military demands, the chief difficulty is not the supply of synthetic rubber but a shortage of tire-manufacturing facilities and trained workmen. After making as many military truck and airplane tires as these limitations will permit, the industry has been able to manufacture a sufficient quantity of passenger car tires to keep essential cars in service, but there will be no new synthetic passenger tires available for non-essential driving until after the end of the European war.

The war has brought to the front a new member of the synthetic rubber family known as Butyl rubber which has very special qualities of resistance to aging and to the action of strong chemicals; and the ability to retain gases many times better than natural rubber.

At the end of the war and after the recovery of the crude rubber plantations in the Far East we believe that there will be sufficient demand for the first three years to consume all of the synthetic and natural rubber that can be obtained. After this period the proportionate consumption of natural and synthetic rubber will depend on their relative prices and qualities.

"Influenza and other Epidemics"

RONALD HARE, M.D.

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January 6th, 1945.

We have no definite record of a disease resembling Influenza until the year 1485 at the end of the Wars of the Roses when a disease, called by Frenchmen "the English Sweat," made its appearance among the troops of Henry VII after the Battle of Bosworth. The disease reappeared in 1507, 1518, 1529, and 1551. After this, influenza gradually became recognized as a specific disease, but it was not until the year 1743 that the name influenza was first generally used. It originated in Italy under the supposition that the disease was due to the influence or influenza of the heavenly bodies.

In its virulent and pandemic form, influenza is comparable with any of the great visitations of pestilence in the past. In 1918-19 it caused

21,000,000 deaths. Outbreaks on this scale and of this virulence occur generally only twice in a century, the previous outbreak having been in 1889.

The more common epidemics of influenza come roughly in two-year cycles and seldom infect more than two continents. In both the northern and southern hemispheres they occur in the winter months. Though not usually fatal, this type of influenza afflicts rather less than 10 per cent of the population. For this reason, during a period of about three months in recent epidemics in Europe and North America, about 52,000,000 persons were infected so severely that they took to or should have taken to their beds.

Unlike many other diseases, such as mumps, chicken pox, and measles, which give an immunity lasting through life, the period of immunity following influenza is relatively short and several attacks in the course of a lifetime are common. The disease spreads along lines of transportation, and isolation and quarantine have been found impracticable as means of controlling the spread of infection. Since it is caused by a virus or several different viruses, it is possible that we may be able to immunize ourselves. To such an end a vaccine would be required, and in order to make a vaccine it is necessary to have a large-scale source of virus. For this purpose living, fertile hens' eggs are used. A vaccine was given very extensive trials during an epidemic about a year ago. About 6,000 people received the vaccine and another 6,000 were left as controls. When the epidemic arrived, only 138 in the immunized group got influenza whereas 442 in the control group were infected. This, at best, is only a partial success and the whole experiment will have to be repeated a number of times before we can adopt or condemn the method of immunization in question.

Other great pestilences have, from time to time, visited the human race and altered its history—plague, smallpox, typhus, cholera, and yellow fever among them. One of the worst of them visited Russia after the revolution in 1917 when there were at least 30,000,000 cases of typhus between 1918 and 1923. The effects of pestilence in modifying the course of history are exemplified by the Antonine or Long pestilence of A.D. 165, the plague of Justinian in A.D. 541, and the Black Death of 1348. The first played a great part in the break-up of the Roman Empire and the fall of the Han Dynasty in China, the second contributed to the downfall of the Byzantine Empire, and the third had profound effects on the whole economic structure of Europe.

Since the birth of bacteriology and preventive medicine, such pestilences have ceased to trouble the human race. It is probable, however, that in the biological world as a whole, epidemics actually serve a useful purpose in limiting the natural increase of any one species and we have

now begun to interfere with this cycle. What the ultimate consequences to the human race are likely to be must be left for speculation. Nevertheless we are probably interfering with Nature at our peril.

"Astronomy in Troubled Times"

HARLOW SHAPLEY, A.M., Ph.D., Sc.D., LL.D., Litt.D.

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January 13th, 1945.

The war has shown the science of astronomy in a new light to many people who looked upon it as a rather aesthetic philosophical pursuit. Its training has proved to be almost shockingly utilitarian for the purposes of war. In the United States nearly 80 per cent of astronomers are engaged in war work, where their experience in optics, mathematics, movements of bodies through resisting media (ballistics), and navigation is found to be of value. As a result most observatories are running only about 50 per cent of normal.

Nevertheless, in spite of this diversion, work in astronomy has progressed during the war years. A sub-dwarf star ten times fainter than any discovered hitherto was discovered at the Macdonald Observatory in Texas. It is 21 light years distant and its smallness and coolness shows a closer approach to the larger planets than any star previously observed.

For the first time an atmosphere has been established for a moon. Analysis has revealed that Titan, one of the satellites of Saturn, has an atmosphere consisting of methane, and probably ammonia. Advances have been made in solar work. By the use of a new instrument observations have been made of fringes in the polar regions of the sun. These fringes consist of what have been called spicules or little spikes, apparently caused by explosions which erupt one to two thousand miles high. It is deduced (observations can be made only on the rim of the sun) that there are two million of them occurring at any one time over the surface of the sun; with what effect on solar radiation has not yet been guessed.

An analysis has been made of 200 years of observation of Mercury's orbit. The analysis appears to verify the Einstein theory of relativity for this orbit: that is, the Newtonian theory when corrected by the relativity theory explains peculiarities of the planet's orbit. The same results have now been obtained with respect to relativity and the earth's orbit.

An important analysis has been made of all the work done in measuring the velocity of light. In this analysis no evidence has been found that there is any variation in the speed of light in vacuo. Speculations to the contrary have not been supported. This finding is of the utmost importance, as the velocity of light has been the basic constant in all relativistic astronomical calculations. Important results have also been announced recently with regard to the distance to the sun.

In spite of these developments the effect of the war has probably been to retard astronomy because of the large number of astronomers diverted from the field. This may be offset by post-war improvements in instruments and new developments in the study of optics.

"The Story of Steep Rock Iron Mines"

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January 20th, 1945.

The first part of the story of Steep Rock Iron Mines, which is Canada's first rich iron mine, commenced in 1897. In that year, Government geologists, making a survey of the Rainy River District of Ontario, reported the presence of boulders, gravels, and sands to the south of Steep Rock Lake, carrying large quantities of iron ore, and suggested that high-grade iron orebodies lay beneath the waters of the lake.

Many years later, in the early months of 1938, diamond drill holes put down from the ice covering Steep Rock Lake, passed through about 150 feet of water, 100 feet of earth, and below this, discovered the hematite orebodies.

To bring this ore into production it was necessary to divert a large river, and dam off and remove the waters of the lake. This was a large engineering feat, requiring the assistance and co-operation of the Canadian, Ontario, and United States Goverments, the Canadian National Railways, and the Hydro-Electric Power Commission of Ontario. The cost of the operations and its associated requirements of power, rail, and dock facilities amounted to about seventeen million dollars.

The diversion of the Seine River required deep, wide canals cut in rock and earth, tunnels as big as subways, dams, and other structures. Fourteen large centrifugal pumps were used to lower the waters of Steep

Rock Lake, pumping a maximum of 322,000 gallons of water a minute, enough water to supply all the needs of the fourteen leading Canadian cities.

Two years were required to complete the diversion of the Seine River, pump the lake, and remove the earth or overburden from over the "B" orebody. Late in the autumn of 1944, the first boatload of Steep Rock ore left the head of Lake Superior for eastern blast furnaces.

There is no doubt that Steep Rock will repay the effort, the years, and the millions spent in making it a mine. In the "A" and "B" orebodies alone thirty-one million tons of high-grade iron ore have already been proven, and this is only the beginning in the exploration of the orebodies. The "B" orebody is being worked by open pit mining, the cheapest of methods, and later the "A" orebody will be opened up in the same way. The ore is of a quality rare now in the Lake Superior District where the mines on the American side are becoming old and, having mined out their best ore, are turning more and more to the production of low-grade ores.

Steep Rock is Canada's first large, rich iron mine, and Canada, which has until now imported almost all of its iron ore from the American Ranges, can now reverse the trend and may do more. The next generation will probably see considerable expansion in Canada's iron, steel, and associated industries.

"The Aztecs of Mexico"

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January 27th, 1945.

In the archaeological study of the ancient civilizations of what is now Mexico, four periods appear. The first is traced back to an estimated date of 500 B.C. This is called the "Middle Culture" period and lasted until 600 A.D. It was succeeded by the Teotihaucan civilization which was wiped out by a pestilence, and followed by the "Dark Age" which lasted from 1100 to 1300 and is otherwise called after the Chicchimic tribe. The Aztecs came upon the Central Mexico scene around 1300 and thrived until the coming of Cortes and the Spaniards.

In unearthing the most ancient of these civilizations, archaeology owes a great debt to the rubbish piles they left. The most remote civilization

was of an agricultural people who deposited in the same heaps both their rubbish and cornstalks, the mould of the latter proving an excellent preservative for figurine gods and other discarded household goods from which to make a reconstruction of the past. Another fortunate circumstance for the present day excavators was an ancient belief that the world might come to an end every 52 years. In this belief the Aztecs and their immediate predecessors periodically threw on the dust heaps much of their worldly goods and knick-knacks.

The earliest crude sculpture of this continent is attributed to this middle period. There is evidence that the impulse for the art originally came from Asia. As the centuries advance the figurines show a growing effort to express vitality, an increasing sense of proportion, grace, and sophistication.

With the coming of the Teotihuacan civilization there are signs of the introduction of ceremonial rites. The former rough religious mounds are displaced by elaborate temples; and for the first time figurines appear which were produced by molds as well as good stone sculpture. The "Dark Age" from 1100 to 1300 which followed the pestilence and the civil war which ended the Teotihuacan civilization is becoming each year less of a closed book archaeologically and historically.

One of the main sources of our information about the Aztecs is their picture writings, many specimens of which are in the British Museum. In these we can read much of the everyday domestic life of the people, including such routines as the training and disciplining of children as well as chronicles of their politics and tribal wars.

The basis of this civilization, as that of its predecesors, was farming, but the Aztecs developed many other arts and skills. They had a highly developed system of jurisprudence. Their architecture was reflected in a great city which they built in the middle of a lake on the site of what is now Mexico City. The Spanish razed it and filled in its canals. Great temples, including the famous pyramid to the Sun, show the development of their religious organization. They had a wide and broad view of the universe, although they did not interpret it as we do. One of the great stumbling blocks to the solidarity of the Americas is the social and political problem presented by the descendants of the Aztecs who for three centuries had been held largely as slaves and yet who, given half a chance, are extraordinarily gifted. It is the same problem that attends the spread of democracy the world over.

"Future of the Helicopter"

FRANK H. KELLEY, Jr., B.S.Ae.E.

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February 3rd, 1945.

Although the predictable practical uses of the helicopter are many, there is a danger that the public has been "oversold" as to its general operation in the near future. At its present stage of development it is far from foolproof. Much greater reliability and simplification will have to be attained before it comes into use by the general public. The time is not yet for the housewife to worry about the laundry being blown off the line by the rotor blades of a helicopter landing in the back yard. The idea of using this machine for shopping trips or visits to the neighbours is in the realm of fantasy.

Unlike the aeroplane, the helicopter can take off or land in a clearance of only 50 feet radius. This gives it unique advantage in rough and difficult terrain and offers competition with no existing means of transportation save canoe or mule. Among its probable practical uses, where its special performance, especially its ability to hover, would be of advantage are: in rounding up cattle on ranches or looking for sick cattle which have got separated from the herd; inspecting power lines; checking rails for wash-outs ahead of trains; inspecting pipe lines; rescues at sea from rubber boats; and in navigation. It is possible that every ocean-going vessel will carry a helicopter machine. For making short trips to land with passengers or freight it could save the time and expense of docking. Also it could give valuable assistance in mooring vessels in harbour.

A practical application of the use of the helicopter in rescue work was demonstrated this winter during the great December snowstorm. A test pilot bailed out at high altitude. On the descent his feet were frostbitten and he found refuge in a remote, snow-bound farm house inaccessible by any ordinary means of transportation. A doctor was flown to him by helicopter and this quick medical attention probably obviated the necessity for amputation.

The great manoeuverability of the helicopter has already been demonstrated by flying it indoors in large stadiums. It can hover and move slowly in any direction. It has also been landed on the roofs of buildings Nevertheless it is still as difficult to fly as a light aeroplane. It is unlikely that it will be cheap in the near future.

The experimental machines now in operation have a cruising speed of 80 miles per hour and give about 15 miles per gallon of gasoline. Last summer one was flown twenty-five hours without servicing. They have a ceiling of 11,000 feet. It is predicted that the helicopter in future will have a jet-propulsion power plant.

"Bakelite Plastics To-day and To-morrow"

WILLIAM J. CONNELLY.

Manager of Consumer Relations Division, Bakelite Corporation, New York, N.Y.

February 10th, 1945.

To-day the outstanding applications of plastics are to purposes of war for which they are essential. With the coming of peace, changes in design and applications will result in more extensive uses in everyday life.

It is a mistake, however, to suppose that plastics will displace other and older materials such as wood, glass, and steel. Synthetic plastics are extraordinary and demonstrate many outstanding properties never before obtained, but they will also serve to augment or enhance natural substances rather than to displace them. A good illustration of this is found in shatterproof glass. No window made of glass alone, nor any window made entirely of plastics possesses all the exceptional advantages of modern safety glass which is made of layers of glass and vinyl butyral plastics.

All plastics may be divided into two main types: thermoplastic materials and thermosetting materials. The former have been known ever since the beginning of civilization; when heat is applied to them they become soft and workable and then, when allowed to cool, they become rigid and harden. The hardened material can then be remelted by the application of heat and this process can be continued indefinitely.

Thermosetting plastics, when subjected to heat, become hard or rigid and once "set" cannot be softened again. They were developed just after the beginning of the twentieth century and since then there has been considerable further development in kinds and uses. "Bakelite" and "Vinylite" plastics are made in a wide variety of forms including liquids, gums, granules, films, sheets, rods, and tubes. A wide variety of these compounds is necessary because no one plastic possesses all the necessary properties for every use.

Were it not that plastics are essential in war, one could to-day think of sheer plastic stockings, colorful shower curtains, plastic rain capes, beautiful molded radio cabinets, and a host of futuristic applications. But plastics are doing an important job in the war.

To mention some military applications: A transparent plastic film which to-morrow may make attractive window drapes, now makes the so-called "Bunyan Bag" which has been credited with saving many lives, especially of seamen badly burned in oil-flaming seas. This bag fits over a burned limb in place of bandages. Through tubes medication is inserted completely surrounding the wound and, since the bag is transparent, the surgeon can observe the progress of the treatment without the necessity of removing the bandages. Other wartime uses for plastics include: Non-skid floor covering for gun emplacements on battleships which has increased the accuracy of naval gunnery 35 per cent; the plastic desalination kit into which a chemical is introduced which turns sea water into potable drinking water; a film bag for rifles which, besides protecting them in amphibious landings, will, when inflated, form a temporary life-jacket for the gun and keep it afloat if it drops from the soldier's hands into the sea; and a molded plastic bomb rack used on "Mosquito" Bombers which is lighter than aluminum or magnesium.

"Magnesium—Lightest Commercial Metal"

L. M. PIDGEON, B.A., B.Sc., M.Sc., Ph.D.

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February 17th, 1945.

The main advantage of magnesium lies in its relative strength and lightness. It is two thirds the weight of aluminum and one quarter the weight of steel. While it has not the strength of either of these metals, its strength comparative to its weight makes it valuable where the factors of lightness and rigidity are important—as in aeroplane structures.

Until about 50 years ago weight was considered an essential property of metals. All the classical metals are heavy—from two to six times as heavy as ordinary rocks or stones. Metals have been known for about 5,000 years but light metals are only half a century old. It is a paradox of metallurgy that the most plentiful metals have been the last to be discovered. This is because it is very difficult to extract them from their ores, and only recently has the technique been developed.

Magnesium is the third most plentiful commercial metal in the earth's crust; aluminum and iron alone being more abundant. The difficulty in recovering it was in separating the metal from oxygen. This was impossible up to the time of the electric furnace. It requires 10 kilowatt hours to make a pound of magnesium or the equivalent of a 50 watt light bulb burning eight days and nights. Canada has an abundance of electric power, and of dolomite ore, from which magnesium may be recovered, and is thus in a most favourable position for the development of the magnesium industry.

Before the war Canada produced no magnesium. But a plant at Renfrew now produces more magnesium than was made on the entire continent before the war; enough to supply Canada as well as some for the United States.

All magnesium came from the sea originally. It is present in many common sedimentary rocks. It is a minor constituent of sea water yet one cubic mile of sea water contains enough magnesium to last the world for twenty years at present consumption rates. The Niagara escarpment is a magnesium ore.

The challenge is to find post-war uses. Its principal structural use in war is in aircraft parts, wheels, brackets, landing gear, and engine parts. Its peace-time uses will be in products where lightness, rigidity, and strength are needed. Possibly one of its important uses will be in commercial vehicles. Among its advantages is that it lends itself to intricate castings and can be machined better than any other metal. Economically, while it is more expensive than aluminum by weight, it is somewhat cheaper by volume.

"The Gun Director's Conquest of the Robot Bomb"

C. A. LOVELL, M.A., Ph.D.

Bell Telephone Laboratories Incorporated, Murray Hill Laboratory, Murray Hill, N.J.

February 24th, 1945.

It used to be said of the anti-aircraft branch of artillery that "it shoots at nothing and hits it." The apparent immunity enjoyed by the German air force over the low countries in 1940 led to the basic idea for electrically directed anti-aircraft fire. The gun director which resulted was originally designed for use against aeroplanes, but, as it turned out, its use was more effective against robot bombs. The fact that the robombs

keep on a direct course at an unvarying speed makes them test targets for the gun directors.

When in August, 1944, the anti-aircraft batteries equipped with gun directors were deployed along the English coast from the Thames estuary to Hastings, their effective shooting against robombs rose to 76 per cent. There is good evidence that the percentage could reach and be maintained at as high as 90 when the condition is reached that each robomb be located by a tracker.

The gun director consists of two separate units. First, the tracker which locates the robomb on the radar principle. It determines the speed and direction of the robomb. This is communicated to the second unit, the computer, which automatically and electrically computes the point in space for the battery's shells to explode on the robomb's path. The computer not only makes these calculations but automatically trains the anti-aircraft guns. In the whole operation only the cutting of the fuses is done manually. The automatic computation is done, corrected to the following variants: the speeds of the robomb and shell, the distances vertically and horizontally, the curvature of trajectory, density of air, wind velocity and direction, muzzle velocity, and the distance of the tracker to the battery. The computations must be corrected to changes in the muzzle velocities and air density, and also to the time consumed by the director's own mechanism.

For the first few weeks after the appearance of the robombs the anti-aircraft batteries were concentrated around London. This presented the danger of firing on our own fighter planes attacking the robombs. In August the AA batteries were deployed along the coast. The percentage of robombs brought down increased from week to week as follows: 11, 17, 24, 27, 40, 54, 74, 76.

The Germans tried sending over a decoy robomb and when this had emptied the AA batteries it was followed quickly by a covey of robot bombs. Now the fire of each battery is limited strictly to a defined arc. One battery is efficient per robomb.

The robombs which did get through to London destroyed 2,300 homes, damaged 1,000,000, and killed 5,000 people. When the AA was moved to the coast it was estimated that robombs brought down over the open country of Kent were 95 per cent defeated. Those brought down over the channel, the majority, were 100 per cent defeated.

"Down the Mackenzie River"

V. C. WYNNE-EDWARDS, M.A., F.R.S.C.

Associate Professor of Zoology, McGill University, Montreal.

March 3rd, 1945.

In 1944 the Department of Fisheries began an investigation of the fisheries of the Mackenzie district in connection with the North Pacific Planning Project, a joint undertaking of the Canadian and United States governments. Two parties were sent into the field. One worked on Great Slave Lake. The other party descended the whole length of the Mackenzie River by freighter canoe. A side trip was made by air to Great Bear Lake and another up the Canol Highway toward the Yukon border. The trip occupied the months of June, July, and August.

The trip down the Mackenzie River was in the nature of reconnaissance, rather than a detailed survey, to get a broad picture of the fisheries resources of the river. More careful inquiries will have to be made in the future by parties making special studies of particular areas.

As food for men and also for dogs, fish is the most important item throughout the Northwest Territories. Virtually all winter travel is by dog team. There are about 2.5 dogs per human being. A dog consumes up to 1,000 pounds of fish per year and the total annual consumption of fish is reckoned in millions of pounds.

The Mackenzie River is not equally productive throughout, the richest waters being the 300 miles between the Ramparts of Good Hope and the sea. The principal species of economic importance are whitefish, lake herring, inconnu, lake trout, northern pike, and grayling. The inconnu, which grows to 60 pounds, is not found anywhere in Canada except in the Mackenzie's tributaries, but it has close relatives in Siberian waters. The Arctic grayling, which grows to about two pounds, is a good sporting fish as well as good eating. A minnow was found whose nearest relative is 1,700 miles away in the rivers of Nebraska.

While fish is the principal source of food, there are magnificent garden and farm crops. The growing season is short but effective since the summer days are long and warm up to 88 degrees. The current of the Mackenzie is swift and uniform for many hundreds of miles and is interrupted by only one unnavigable rapids. Its delta is almost as large as that of the Mississippi, and is scientifically remarkable for the hills along its eastern border, more than 500 feet high, and composed of alluvial matter brought down by the river in past times.

As the main mode of travel, sleigh dogs have been and will continue to be an important part of the economic set-up of the Mackenzie valley. The development of the entire territory, however, is wrapped up in improved communications and transportation.

"Your Teeth—Your Health"

R. G. ELLIS, B.D.S. (Adel.), D.D.S., M.Sc. (Dent.).

Professor of Operative Dentistry, Faculty of Dentistry, University of Toronto.

March 10th, 1945.

The development of a tooth may be described by an analogy with the building of a house. First there is the blueprint stage when the plans are laid and the workers hired; in the tooth this would correspond to the period when the cells start to differentiate and line up for the job. The construction of the foundation would parallel roughly the beginning of the tooth's calcification. The walls and structure might be compared to the stage when the tooth partly completes calcification and the initial eruption. In a house that would leave only interior decorating; in the tooth it leaves only the completion of the roots and insulation for the nerve.

But where this process might take a year for a house, it takes ten years for a tooth. Over this decade of formation the amount and quality of the food (or building materials) will determine the quality of the tooth as a finished product. Other factors besides the nutritional value of the food are involved in the formation of healthy teeth. The general health will also have an affect. For instance, a disturbance of the endocrine glands with consequent faulty metalbolism would result in poor teeth. External injuries play a part also. And in some sad cases, for unknown reasons, teeth have failed to erupt at all, or only a few have erupted instead of the natural thirty-two.

The malocclusion of civilized peoples' teeth is becoming serious. This results from the physical, as distinct from the nutritional, properties of diet. The teeth are being put out of alignment through lack of function. Knives and forks are taking over the tasks of prehension and incision, and soft foods removing much of the necessity of chewing.

This lack of function appears to be having a hereditary effect. In many cases the third molar fails to erupt and this has led to speculation as to whether in the course of time it may not disappear from the race. A somewhat similar condition is observed with respect to the upper lateral

incisors which, owing to lack of function in biting and tearing, frequently fail to form.

Under these conditions the arch of the mouth tends to grow narrower and in the restricted areas the back molars, pressing for room, push the front upper incisors forward to overlap the lower teeth.

The moving pictures shown of Indians and Eskimos in the Mackenzie delta, the eastern Arctic, and Labrador illustrate the comparison of the malocclusion of civilized peoples' teeth and the perfect functional alignment of the teeth of natives living in primitive conditions and eating tough, fibrous food. The deterioration of Indians' and Eskimos' teeth after living only one generation in a civilized environment is very marked.

An improvement in this condition should be affected by the inclusion of tough fibrous food in the diet; the proper use of a toothbrush to remove carbohydrate debris which causes decay; a balanced diet for nourishment and pre-school age dental clinics for the care of milk teeth which have an important bearing on second dentition.

"Recent Chemical Developments and some of their Applications"

MARK E. PUTNAM, A.B., M.S., Sc.D.

Vice-President of the Dow Chemical Company, Midland, Michgan.

March 17th, 1945.

War, the acute immediate fight for survival, is certainly the most powerful possible stimulus to scientific research, but the miracles our chemists, physicists, biologists, and metallurgists brought forth in the last four or five years are for the most part the posthumous children of generations of men who worked basically with the human faculty of imagination.

One of our newest developments in chemistry is a family of materials known as silicones. Actually the first silicone compounds were made in 1870. The great English chemist, F. S. Kipping, worked on these compounds from 1899 to 1939 and in a summary of his work published in 1937 he concluded "the prospect of any immediate and important advance in this section of organic chemistry does not seem very hopeful." That was just on the eve of startling applications. It was in that same year

that serious work was begun by the Corning Glass Company which later availed itself of the personnel and facilities of the Dow Chemical Company and the Mellon Institute with such promising results that about two years ago the Dow Corning Corporation was formed for the exclusive purpose of manufacturing materials of silicone compounds.

Silicones are often referred to as products of the chemistry of sand because they revolve around the element silicon. Former organic compounds were grouped around the carbon atom. The silicone compounds are similar except that they are grouped around the silicon atom. Carbon will burn; sand will not. Silicone compounds undergo very little physical change when subjected to varying temperatures. In addition they have excellent electrical properties and are extremely resistant to water. One of the most important applications of silicones to date has been an ignition sealing compound for aircraft ignition systems. The electrical disturbance known as corona (loss of electric energy, especially marked at high altitudes) for years made it impossible for a plane to operate successfully above 20,000 feet. A silicone compound resembling a white grease smeared over ignition cables eliminates corona and has raised the ceiling of our fighter planes to 30,000 feet. One of the materials which Kipping, who probably knew more about silicones than any living man, reluctantly concluded showed "little promise," has given us a new and deadly type of air supremacy.

Styrene, like the silicones, was known to science long before its practical application. Although it seems new to us styrene was first prepared in the laboratory more than 100 years ago. It is one of the two legs upon which the synthetic rubber industry stands. The plastic forms of styrene known as polystyrene have the advantage of lightness and cheapness, and outstanding electrical properties and crystal clarity which rivals that of the best plate glass. Here is an instance of materials the basis of which was known for 100 years but which remained of no practical use until other phases of science had gone forward opening up the way for their application.

One of the most intriguing scientific developments of the past six years is the extraction of magnesium from sea water. The germ of the idea of extracting metal from sea water probably came into being in 1884 when an English scientific expedition revealed more than thirty elements in the ocean. It is now generally assumed that every known element is there.

In 1940 we turned to the ocean as a new and unlimited source of magnesium. The site for the plant was 140 acres near Freeport, Texas. The concentration of magnesium in sea water is only 1.280 parts per million. The sea water is drawn from a ship canal and drained through large rotary screens. Four centrifugal pumps handle more than 300

million gallons of water every twenty-four hours and the product passes through giant thickening tanks, lime kilns, and evaporators.

This marvel of taking metal from water came about through no accidental circumstance, but rather through the thoughtful utilization of knowledge gained through the centuries. While the chemist may have conceived the process, converting it from a laboratory bench to 140 acres of land beside the ocean became dependent on the engineer, the physicist, and finally the business executive.

"To the Interior of Eastern Quebec with a Camera"

PAUL PROVENCHER, F.E.

Chief Forester, Quebec North Shore Paper Company, Baie Comeau, Que.

March 24th, 1945.

The northeastern interior of Quebec has been explored by few white men. Around the end of the last century and the beginning of this there were a few historic explorations, one, the Hubbard expedition, ending tragically. But very few white people have felt the urge to undertake the trip to territories which, in the northern tablelands at least, are very uninviting.

The area of which motion pictures and slides have been taken begins about 135 miles east of the Saguenay River and in the early days of the colony was known as the Kingdom of the Montagnais Indians. Up to 1914 little was to be seen in this vast solitude except a few small trading posts and some very old settlements scattered along the coast. The chief occupations were trapping and fishing.

The north shore commenced to progress after 1923 when pulp and paper mills came in and villages grew with the promise of a great future for this country. Forests, fisheries, and mines offer the greatest promise rather than agriculture since there is little arable land and the season is very short. The natural beauties of the Laurentian forests make them ideal for recreation and hence an attraction for tourists. The great water powers in close proximity to bodies of ore hold out the prospect of extensive smelting industries.

Further north, one reaches the plateau with its labyrinths of shallow lakes. It is almost the image of desolation and was described by Cartier as "the land God gave Cain." Here the novice explorer must beware. The very abundance of waterways is confusing. The mineralized rocks

deflect compass needles. There is danger of starvation as the fishing season is over by September and the explorer should be equipped with fishing nets.

South of these barren lands, the country offers fascinating beauty which captivates nature lovers. Quiet lakes and rivers surrounded by balsam-laden forests, leaping cascades and falls, with everchanging pictures of sky that store up treasured memories for months after return to civilization. The fishing is excellent and the sight of salmon jumping up the cascades an experience to be remembered. As many as a thousand salmon jumping up waterfalls may be seen in one day.

Forest fires are the greatest menace, destroying in a few hours the work of nature over centuries.

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OF THE

Royal Canadian Institute

SERIES IIIA SESSION 1945-46 VOL. XI

This publication is issued with the object of conveying a general idea of what the Royal Canadian Institute endeavours to do, along with a brief outline of what it has done in the past. The publication contains abstracts of the popular scientific lectures given each Saturday Evening in Convocation Hall, University of Toronto, during the 97th Session, 1945-1946.

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THEN AND NOW

THE Royal Canadian Institute has as its object the promotion of science and the results of scientific research. It attempts to inform and educate the public on important matters of general interest; to stimulate research and to act as liaison between the scientist and the public.

The Institute was established in 1849 in Toronto, at that time the capital of Upper Canada, by a small group of surveyors, architects, and civil engineers. When incorporated in the Province of Upper Canada in 1851 it was definitely to serve Upper Canada which, in the enlarged Dominion of Canada, came to be the Province of Ontario. If it had been established after Confederation it is likely that it would have been called the Ontario Institute.

The original members of the Institute were William E. (later Sir William) Logan, John O. Brown, Frederick F. Passmore, Kivas Tully, William Thomas Ridout, and Sandford (later Sir Sandford) Fleming. Of these, Sir Sandford Fleming, the originator and founder of the Institute, was the last survivor.

A story of interest from the pen of Sir Sandford Fleming, a great Canadian and a pioneer in engineering, describes the enthusiasm of the early founders:—On February 8th, 1850, a meeting was held to discuss plans for the newly formed organization. Only two members attended, F. F. Passmore and Sandford Fleming The prospects of the young Institute were not brilliant, but the two determined to act with energy, if not with entire regularity. After much silence and long waiting in vain for other members to appear, the one addressed the other in these words: "This looks bad—we must, however, proceed, as the saying is, to make a spoon or spoil the horn. Let one of us take the chair and the other act as secretary," and so agreed, dispensing in the emergency with a quorum, they passed a series of resolutions with complete unanimity. No amendments were offered and time was not spent in long discussions; those present deemed it a dispensable formality to have "movers" and "seconders" to the motions submitted. As appears by the minute book the meeting simply "resolved" this or that. One resolution adopted and formally placed on record, reads: "Resolved, That the members of the Canadian Institute do after this date meet once a week, on each Saturday at 7 o'clock p.m., in the Hall of the Mechanics' Institute. The first meeting to take place on Saturday next, February 16th, 1850." No fault was ever found with the action taken on that occasion and meetings have been held without interruption since that date.

At the earlier meetings, papers on scientific problems of the day were read and discussed and laboratory work was carried on by the various sections which were established under the administration of

the Institute. The most important of these were the Biological Section, the Geological and Mining Section, and the Historical Section.

The early publications of the Institute, beginning with the year 1851, were also of great value because they were the only ones of their kind in the scientific field in Canada. The first of these publications, "The Canadian Journal: a Repertory of Industry, Science, and Art," was edited by Henry Youle Hind, who conducted explorations in western Canada, and there followed the well-known series on "Toronto of Old" by the Rev. Henry Scadding, D.D., who was President of the Institute from 1870 to 1876.

When the Canadian Institute moved from its building at the corner of Richmond and Berti Streets in Toronto in 1905 to become more closely associated with the University of Toronto it began to establish a more direct communication with the public. On April 2nd, 1914, His Majesty the King granted permission to the title "Royal" and it became the Royal Canadian Institute.

In aiding the public to appreciate and understand the value of research, the Institute has had an important influence in increasing research facilities in Canada. During the First World War the Royal Canadian Institute established a Bureau of Scientific and Industrial Research to promote closer co-operation between science and industry in the prosecution of the war. As a result of publicity given to the value of enlisting scientific aid in the war effort, the federal government appointed an Honorary Advisory Council on Scientific and Industrial Research which later developed into the National Research Council with extensive laboratories in Ottawa. Public realization of the value of science after the war led to the establishment of the Ontario Research Foundation and to increased grants for research in the universities.

During the last few years the Institute has been playing an important part in the promotion of the conservation of our natural resources. It co-operated in the formation of the Guelph Conference organized to study these problems and make representations to the Provincial Government.

Scientific research was never more necessary than it is to-day in enabling us to develop the resources of our country so that they will yield the greatest possible return. The public should be enlightened on the applications of science to modern problems.

The contributions of science to our material welfare are, however, only a part of its significance to mankind. Probably even more important is its general educational value. It opens to us a broader vision of the world, developing more accurate habits of thought, and thus leading to a greater enrichment and enjoyment of life. For these reasons the educational work of the Royal Canadian Institute is one of the most valuable of its activities.

Some of the Outstanding Accomplishments of the Royal Canadian Institute

1. Co-operation in promoting the meetings in Toronto of the following scientific societies.

(a) The American Association for the Advancement of Science, 1889 and 1921.

(b) The British Association for the Advancement of Science, 1897 and 1924.

(c) The International Geological Congress, 1913.

(d) The International Mathematical Congress, 1924.

2. Standard Time.

In 1878 Sir Sandford Fleming brought forward the plan of adopting for the whole earth twenty-four standard meridians, fifteen degrees apart in longitude. He published many papers on this subject, and with the co-operation of the Institute, the zone system of time-reckoning was adopted in most of the countries of the world.

3. The Museum.

The Ontario Archæological Museum was begun under the auspices of the Institute, and continued under its management for six years before being transferred to the Ontario Government and the University of Toronto.

4. The Ontario Good Roads Association.

The Ontario Good Roads Association was organized as the outcome of a meeting called bv the Canadian Institute in 1894.

5. The Publications.

The publications of the Institute have appeared as follows:—

(1) "The Canadian Journal: a Repertory of Industry, Science, and Art," and a Record of the Proceedings of the Canadian Institute. 3 vols., 4to. Begun August, 1852, ended December, 1855.

(2) "The Canadian Journal of Science, Literature, and History." 15 vols., 8vo. Begun January, 1856, ended January, 1878.

(3) "Proceedings of the Canadian Institute." 7 vols. Begun 1879, ended April, 1890.

(4) The Archæological Reports of the Canadian Institute were published as part of the Appendix to the Report of the Minister of Education for the Province of Ontario, 1886-1894.

(5) Minor Series. "Proceeding of the Canadian Institute." From 1897 to 1904, two volumes of this series, containing short papers, were published.

(6) "Transactions of the Royal Canadian Institute." Begun October, 1890, and up to October, 1945, twenty-five volumes have been published. This publication contains scientific papers on technical subjects relating to all branches of science. These papers are submitted by those doing research work. The publication is sent to learned societies throughout the world, and these societies send their own publications in exchange. Any Ordinary member of the Royal Canadian Institute may receive a copy of this publication upon request.

(7) "Proceedings of the Royal Canadian Institute." Series IIIA. Abstracts of the lectures given during the year. Begun 1936 and to date eleven volumes have been published.

(8) General Index to Publications, 1852-1912. Compiled and edited by Dr. John Patterson. Dr. J. B. Tyrrell, President of the Institute, 1910-1913, undertook to finance the compilation of the index, and made it possible for the Council to proceed with the work.

6. The Library.

As a result of the exchange of publications with learned societies for the past ninety-seven years, the Institute has built up a most important scientific library containing thousands of volumes which are indispensable to scientific workers and are not otherwise available in this part of Canada. This library is housed in a section of the library of the University of Toronto, and may be used by the staff and students of the University as well as by members of the Institute.

7. The National Research Council and the Ontario Research Foundation.

It was in large part due to the vigorous campaign of the Institute on behalf of a wider application of science to industry in Canada, that the Honorary Advisory Council for Scientific and Industrial Research, the forerunner of the National Research Council, was appointed by the Dominion Government, and that the Ontario Research Foundation was instituted through the co-operation of the Ontario Provincial Government and manufacturers.

8. University Grants.

The Institute also strongly supported the successful application to the Provincial Legislature for an annual grant for research in the University of Toronto.

Report of the President

1945 - 1946

As presented to the 97th Annual Meeting, Saturday, April 6th, 1946, held in the Royal Ontario Museum.

In presenting this report, I must first disclaim any credit for the organization of the past season's work. Mr. Eadie, your President elected a year ago, found it necessary to resign in December, 1945, owing to his having to move to Montreal. He left behind him a well-organized programme which has taken very little attention on my part to carry out.

The public lecture programme this year consisted of twenty lectures given as usual on Saturday evenings in Convocation Hall, beginning November 3rd, 1945, and ending on March 30th, 1946. The total estimated attendance was 22,600 which is an average of 1,130 per lecture. On two occasions, namely the lecture on "Wildlife in Action" by Dr. Pettingill and that on "Liquid Air—Its Properties, Uses, and Misuses" by Dr. John Satterly, it is estimated that two or three times the capacity of Convocation Hall was turned away.

The entertainment of our speakers was arranged by a committee with Dr. Agnew as chairman. This is an important function of our operation and all our lecturers have commented favourably upon the hospitality shown them while in Toronto.

There is very little doubt that there is a growing appreciation of these lectures on the part of the public. This is indicated by the report of the Membership Committee which shows that 286 new members were elected this year; an all-time record. The Membership Committee was responsible for obtaining 106 of these while the membership at large sponsored 142 applications. It is significant, however, that 37 applications were received from unsolicited sources. This healthy growth is further emphasized by the fact that there were only 76 resignations, which with 24 members deceased, gave a net gain of 186 new members for the year. The total membership now stands at 1,921. The Membership Committee, so ably directed by its Chairman Dr. Meen, is to be congratulated on this record.

Also great credit for the growth in interest must go to the Publicity Committee under Mr. Publow as chairman. The thanks of this meeting must include Mrs. O D. Vaughan who arranged so ably for advance press notices and the weekly press interviews of the various lecturers. Certain of our lectures have been considered of sufficient interest and importance by commentators to be referred to on the radio broadcasts.

May I emphasize strongly the necessity of continuing a well-organized publicity campaign?

Your Council presented a brief this year which was presented to the Royal Commission on Secondary Education. In this brief, the importance of the Royal Canadian Institute lecture system in stimulating public interest in the necessity and advantage of education was stressed; and it was suggested that this system could be expanded to centres other than Toronto if financial help were provided.

It was also pointed out in the brief that young people in high school should be given more thorough instruction in the way in which they are governed, and also in the responsibilities which go with freedom. Such instruction should, however, be given with no thought of political propaganda.

On the financial side, we have again a small balance to show on operations. The audited statement prepared by our appointed auditors, Mr. H. F. Vigeon and Mr. H. C. Brown, shows a net balance on operations for the year of $678.44. We are to be congratulated in having such a competent Finance Committee under the chairmanship of Mr. John S. Dickson. The audited statement can be seen at the Royal Canadian Institute headquarters.

Dr. E. Horne Craigie, our painstaking Editor, reports that during the session 1945-46, vol. 10 of the "Proceedings" and vol. 25, part 2, of the "Transactions" have been published. The "Proceedings" as usual contains a record of the year's activity. The following two papers were published in the "Transactions": "*Peromyscus Maniculatas Macrorhinus* and the problem of Insularity" by T. T. McCabe and T. M. Cowan; and "A Botanical Survey of Waterloo County, Ontario" by F. H. Montgomery.

The Library Committee under the able chairmanship of Mr. Bruce Murray has given a great deal of thought to the question of the future of the Library. The Royal Canadian Institute has many valuable reference publications among its 33,677 volumes and it continues to receive many exchanges which are also valuable.

It must be recognized, however, that with the growing facilities of the more wealthy organizations such as the University of Toronto Library and the Toronto Public Library, it is a debatable question whether the Royal Canadian Institute should maintain a separate library or whether it should have a Royal Canadian Institute section in one of the other libraries. This problem is one which should be considered and settled immediately by the incoming executive.

For a little over a year, your Council has known that the University of Toronto proposed to take over the Royal Canadian Institute headquarters building at 198 College Street, at a proper valuation, to make room for the new Chemistry building. Consequently your Council negotiated the purchase of a property at 189-191 College St., the southwest corner of College and Henry Streets, which can be converted at a reasonable expenditure into a very presentable headquarters.

Unfortunately, owing to the present housing regulations, we have not been able to take over our new quarters on College Street, as it has been, and still is, used as a rooming house. This faced your Council with the necessity of finding temporary quarters. We were very fortunate in getting space in the building at the southeast corner of St. Clair Ave. and Avenue Road. In this connection, may I point out that the very arduous task of finding these quarters and moving into them devolved on another committee headed by Mr. Frank Publow. He has put an enormous amount of work into this undertaking. Dr. Harvey Agnew, a member of this committee, successfully negotiated for the quarters on St. Clair Avenue West into which we are now moving.

There is a large amount of equipment, etc., which cannot be taken to the new quarters. Dr. Holden very kindly arranged with the University of Toronto authorities to store this equipment in University buildings.

It is problematical as to when we shall be able to take possession of our new quarters on College Street. In the meantime, however, the space is rented and the Institute is not losing financially.

I am pleased to announce that your Council, in co-operation with the Toronto Field Naturalists' Club, has arranged a series of five lectures with the National Audubon Society to be given at Eaton Auditorium on October 16th, November 11th, December 10th, January 13th and February 10th. Notices about these lectures will be sent to the members at a later date.

All arrangements for the entertainment this evening have been made by a committee under the chairmanship of Mrs. O. D. Vaughan, to whom the thanks of the membership are again due.

There are two executive members who are retiring from office this year after having given long and valued service. They are Dr. Sigmund Samuel, Honorary Treasurer, and Mr. George C. Gale, Honorary Secretary. I know we all thank them for their valuable

contribution and are glad to announce that they have consented to continue on the Council where their experience will be very welcome.

Finally, no report of the Institute would be complete without mention of the efficient services of our staff: Mrs. Rawlings, Executive Secretary; Miss Styles, Assistant Secretary; and the Librarian, Mrs. Warrener. We are indeed very fortunate in having this hard-working, efficient and courteous staff.

In conclusion, may I thank one and all members of Council for the help they have given me in carrying out the programme this year.

Respectfully submitted,

T. R. LOUDON,
President.

The Saturday Evening Lectures

One of the objects of the Royal Canadian Institute is to further a popular interest in research. Since the results of research are so far-reaching in their effect upon the life of every member of the community, it is necessary to create an intelligent public who will be able to follow the work and achievements of those who are engaged in it.

What has been done in the past is illustrated by such important accomplishments as the invention of the telephone and the radio, the discovery of radium, the improvement of the telescope, also by the immense access of knowledge as to the structure of matter, whether in the atom or the universe, the manifold phases of life on the earth, and the exploration of the world.

The lectures of the Institute are the medium whereby such work is explained to the public. On Saturday evenings during the season, popular lectures of a scientific nature are given by men outstanding in their own field. The purpose is to interpret scientific research for the public.

"Building Wings for Words"

T. W. EADIE, B.Sc.

General Plant Manager, Western Area, Bell Telephone Company of Canada, Toronto.

PRESIDENTIAL ADDRESS

November 3rd, 1945.

The expansion of the physical scope in the field of communications might best be conveyed by a comparison of telephony of sixty-nine years ago and the present. It was only sixty-nine years ago that the first communication of the spoken word passed over a line between Brantford and Paris, a distance of less than 10 miles. Today, had it not been for interruptions in expansion due to conditions of war, undoubtedly one would be able to speak from any inhabited country to any other country with every assurance that even the finer inflections of the voice would be easily recognized at the most distant point.

Only sixty-eight years ago the first telephone line in the city of Toronto was installed between Mr. Lee's apothecary shop on King Street and his home on Queen Street. It is estimated that last year 635 million conversations were carried over telephone lines in this same city.

The simple hand-operated switch provided the earliest means of interconnecting two physical circuits. Today there is the complicated mechanical device which, speaking of Toronto alone, through the actuation of the dial will connect a telephone with any one of the other 275,000 in the city. The operation of the dial system as a means of establishing connections over long distances is foreseen in the not distant future.

Paralleling the development in the field of wired communication there has been the development in the wireless or radio field. These, it is felt, are supplementary rather than competing means of communication. There is presently no apparent possibility that the transmission of impulses over wires will be replaced by impulses or waves transmitted through space.

In the growth of telephonic communication, one of the greatest problems has been that of carrying the ever increasing number of wires. Long ago a single wire strung on available structural supports, between trees or across roof tops, when coupled with a ground return provided the needed circuit. A single wire soon was replaced by pole lines with crossarms to support many wires. Later, the open wires were replaced by small bunches of wires contained within a cylindrical lead sheath—the whole being called a cable. In time, the aerial construction was replaced by

larger cable in underground conduits. We are continually under pressure to replace the smaller cables by ones of greater capacity. From a single wire on an aerial structure, we have grown to 6,000 wires, each electrically isolated by wood pulp insulation, under one sheath that is not the size of a stovepipe. This provides facilities to interconnect 3,000 stations with any other 3,000 stations. It would have required 100 fully-loaded pole lines to provide an equal capacity.

A toll cable which is capable of carrying 3,000 separate conversations over long distance contains six tubes for broad band transmission, and could if the need arises transmit television signals from point to point. Four hundred and eighty simultaneous conversations can be provided for within the two million cycle band transmitted along the shell of each tube.

"Wildlife in Action"

OLIN SEWALL PETTINGILL, Jr., Ph.D.

Assistant Professor of Zoology at Carleton College and the University of Michigan Biological Station.

November 10th, 1945.

At this lecture selections were shown from six miles of coloured film, some of it in slow motion, which Dr. Pettingill had taken in 20,000 miles of travel in recent years. He said that he hoped the moving pictures would be a reminder that our wildlife resources must not be depleted by neglect but appreciated more than ever before and rigidly conserved for the benefit of future generations.

Among the interesting moving pictures were studies of birds, animals, and reptiles in their natural habitat in the prairies, the mountains, the woodlands and waterways. Most of the film was devoted to bird subjects Among the many interesting scenes in this category was the weird courtship dance of the prairie chicken. Here the birds appear on a "tournament ground," the separate areas apparently marked off by mutual consent, where the males perform their dances. Other pictures showed the wild turkeys of the Georgia pine groves. These are the largest of the inland birds and are capable of strong flight. They are not to be confused with the turkey used for food which is a different bird that originated in Mexico and Central America, was domesticated in Europe and was then brought back to America. The beautiful avocets were shown in slow motion performing peculiar antics in order to distract the stranger from their nests. The acquatic displays of the Western grebe with legs at stern "where an outboard motor should be," and gorgeous tanagers, orioles, hummingbirds and finches were also illustrated.

Of the animals depicted, the prong-horned antelope of the western prairies, the fastest four-footed animal of the continent, demonstrated how a revival of a species could be brought about through rigidly enforced game laws. This graceful animal had been almost exterminated but now has greatly increased. The pictures also showed the problems of a mother possum with her nine young.

In the category of reptiles there were the puff-adder and the side-winder rattlesnake. The former was described by the lecturer as "the world's greatest bluffer" and was shown in its protective defence of feigning death.

"Light as a Means of Survival"

HENRY L. LOGAN, P.E.(E.), Fel.A.I.E.E.

Engineer-Consultant, The Holophane Company, Incorporated, New York, N.Y.

November 17th, 1945.

In mankind's struggle for survival the evolution of the eye has been one of its most valuable safety mechanisms.

Two main properties of the eyes are rod vision and cone vision. The visual function of the eyes is related to their fundamental physiological function as organs to ensure survival of the individual. The cones are the visual agents which convey clearly defined, coloured images to the brain and constitute only five per cent of the retina. The rods convey stimuli to the brain not only for conscious vision but also to initiate reflex impulses to the entire nervous system. It is through the function of the latter that individuals react automatically to the stimulus of light and vision, by ducking, or moving otherwise "instinctively," to avert danger. If we had to take time to think we would be destroyed by the hazards of our environment.

Scientists believe that early human evolution occurred in the neighbourhood of the 70-degree isotherm which is that geographic region where the mean annual temperature is 70 degrees. From this hypothesis it was deduced that the distribution of light in this climate would most nearly approximate the ideal for the human eye and consequently in recent years studies have been made along the 70-degree isotherm with a view to improving indoor lighting.

Successful practical results have followed this study of natural illumination and guide lines have been developed to measure the efficiency of

artificial lighting. By this means it has been revealed that virtually all present lighting systems, including indirect and semi-indirect systems, have common faults of too much light above the horizontal line of sight with deficiency and discomfort below.

The form of lighting which has been found to give almost perfect distribution and comfort and comes closest to optimum natural distributions is large area, built-in direct lighting in conjunction with sufficiently reflective surfaces below. A good example of this is continuous fluorescent lighting flush with the ceiling with proper room finishes.

Up to now the main concern in lighting has been to create a quantity of light which serves the cones but owing to faulty distribution, fails to serve properly the rods of our visual equipment. One result has been a high percentage of preventable accidents under conditions of artificial illumination.

An instrument that would respond to light in all visual zones in the same way as the "standard eye," was developed to make the natural lighting measurements that resulted in the "guide lines" chart (Flux Analysis Diagram).

Another instrument was developed to make the same kind of measurements of artificially lighted fields of view. Diagrams made with the latter are checked against the optimum conditions discovered through the former instrument, and by this means artificial lighting systems can be corrected to correspond to optimum natural conditions.

These developments offer the promise of creating artificial luminous environments that will not only satisfy cone vision (light for "seeing"—object sense and color sense), but will also fully stimulate individuals physiologically, enhancing their safety and well-being in artificial environments.

"The New Status of the Light Metals"

H. H. RICHARDSON, M.Sc.

Vice-President, Aluminium Laboratories Limited, Montreal.

November 24th, 1945.

Under the necessities of war, especially in the field of aviation, the production of light metals was enormously increased. One of the important post-war problems is to find peace-time uses for this greatly enhanced productive capacity in both aluminum and magnesium.

Aluminum production rose to more than five times and magnesium to more than ten times their pre-war figures. In the case of aluminum this meant a jump from 70,000 tons to 500,000 tons yearly in Canada, made possible by the construction of the Shipshaw and extensions to the Arvida plants. This had altered Canada's relative position as an aluminum producing country. Before the war it was third, exporting 60,000 tons of its 70,000 tons annual production. Now Canada is second, ranking next to the United States.

While no aircraft failed to be produced for lack of light metals, the situation during the war was at times critical, especially in one period of 1943 when submarines menaced the supply of bauxite from South America to both Canada and the United States.

It is hoped that uses will be found for at least 200,000 tons of aluminum per year in the combined domestic and export markets, and to this end research work is under way to reduce costs, improve qualities, and discover new uses for the metal. Expansion of the well-known uses of aluminum such as in cooking utensils, and its employment in new fields are the main directions in which the surplus may be taken up.

About new uses, one of the most significant developments is the construction of 50,000 temporary houses of aluminum in England. In these houses the side walls, roofs, floors, and interior partitions are made of aluminum. The experiment offers a valuable field for study of the possible introduction of this metal in the construction of permanent houses. In Canada a factory pre-fabricated house has been built partly of aluminum.

Test houses of aluminum in the tropics kept an interior temperature ten degrees lower than outside.

Another future possibility for aluminum is in the construction of farm buildings and particularly of roofs; its corrosion-resistant properties giving longer life and eliminating the necessity for painting. It is probable that in between five and ten years most automobile bodies will be made of aluminum. Its advantages for this purpose are in its lighter weight and its resistance to corrosion. It would reduce the uneconomic waste of scrapping cars after a short life. The use of aluminum in the construction of railway cars will probably be extended.

"Newer Applications of Photography"

WALTER CLARK, Ph.D.

Assistant to the Vice-President in Charge of Research, Eastman Kodak Company, Rochester, N.Y.

December 1st, 1945.

No very outstanding advances were made in photography as a result of the War. The war-time uses of photography were largely the same as those in time of peace, but the ultimate objective was changed and there was a marked acceleration in the application of known principles.

Among the important military uses of photography was that in the field of reconnaissance. Good results were obtained in night aerial reconnaissance of the enemy retreat across the Rhine. These pictures were taken with the aid of flash bombs. Electric flash lamps were also used but were effective only at low altitudes. Periscope photography, by which pictures of enemy shore-lines are taken from the periscope of submerged submaries, was used in reconnaissance before landings. Advances were also made in underwater photography for exploring enemy obstructions and also in the salvage of sunken ships. Underwater photography presents special problems because of scatter, and the fact that the light transmitted is confined to the blue-green.

Photography was also used in connection with radar, the radar screens of aeroplanes being photographed and the prints later employed in briefing air crews.

High-speed photography with exposures as short as one one-millionth of a second is now in use. This has been employed in the study of ballistics, taking pictures of the emergence of a bullet from a muzzle, and also in the photographic examination of explosions. The combination of high-speed and X-ray photography is another new application, exposures as short as one millionth of a second being attainable. This year, a 100 million volt X-ray machine has been built with unprecedented penetrating power. By the combination of high-speed and X-ray photography it has been possible to photograph the progress of a bullet passing through steel armour. Its industrial use is most important.

Photography by infra-red rays has many applications. It is used in criminology, in detecting forgeries in art, in photographing in the dark or at great distances. It also has important applications in geological and forestry surveys.

Improvements in films and plates have made possible much better astronomical photography. With these more sensitive films and plates it is now possible to obtain results from the 100-inch telescope which it had previously been expected could be obtained only from the 200-inch telescope now in the course of construction. The coronagraph, by which the corona of the sun can be photographed without there being an eclipse, is also a new development in astronomical photography. As a result of the working out of plates specially sensitive in certain spectral regions, much has been learned of the composition of the atmospheres of the planets, and many new stars have been discovered.

"The Story of Plastic Surgery"

STUART D. GORDON, M.B., M.S., F.R.C.S.(C.), F.A.C.S.

Surgeon, Toronto General Hospital, and Chief Plastic Surgeon, Department of Veterans' Affairs.

December 8th, 1945.

It is obvious that a specialty cannot spring full fledged from the parent art as something entirely new, but must have behind it a long and perhaps tortuous time of trial. And so it is with plastic surgery. Speaking generally, plastic surgery is that branch of the art of surgery which deals with the treatment of deformities, be they present from, or acquired after, birth.

Hindu holy books tell of an operation for repairing the lobe of the ear from a fold of skin taken from the neck performed about 3,000 years ago in the upper valley of the Sind. Damage to the lobule probably resulted from the custom of piercing children's ears. Fifteen different plastic operations are described by the Indian surgeons. A common punishment in India at that time was the cutting off of the nose. As a result of this penalty a remedial operation was devised consisting of turning down a flap of forehead skin and grafting it to the nose. This method is still in use and is known throughout the world today as the Indian method of nasal repair. The 6th Century B.C. saw the beginning of a decline in India of surgical science which became more and more buried under taboos, religious doctrine and rules.

Hippocrates, the Father of Medicine, who was born in 460 B.C., was also the first to devise a method in the treatment of a fractured jaw, followed in principle in modern plastic surgery. He tied the teeth together to hold the jaw in place, using either a gold wire or flaxen thread. Galen in the second century A.D. was the greatest medical name in Roman times.

He was the first, so far as is known, to treat hare-lip, thus contributing to the development of plastic surgery.

The fall of the Roman Empire was followed by dark ages for medicine. The surgical renaissance in Europe, when it came, was based on the old Greek culture. From the Renaissance onward there was a slow and gradual improvement in the practice of surgery. Thus towards the close of the 13th Century Jehan Yperman of Ypres treated hare-lip much as originally suggested by Galen. In the 14th Century, Guy de Chauliac treated fractures of the jaw by the Hippocratic method. During the 15th Century an itinerant Sicilian family named Branca revived the operation for nasal repair, the details being passed from father to son for generations. Gaspar Tagliacozzi in the next century became famous for his ability to make new noses. He lifted a flap of skin from the arm and fastened it to the remains of the nose, a special leather harness of his devising holding the arm in position until it was safe to divide the flap.

Other surgeons who have contributed to what is now the specialty of plastic surgery are Dupuytren who described a lesion of the hand which leads to crippling deformity and classified burns according to depth of burn; Diffenbach who described the use of definite shifts of skin to repair defects about the mouth; Langenbach who developed a satisfactory operation for the repair of a cleft palate; and Nelaton with his contribution to nasal repair.

In the grafting of skin which is one of the best known of the plastic operations, two methods are used: attached grafts which have not been completely cut away from the original site, and free grafts in which the skin used is completely detached from another portion of the body.

In the first great war for the first time in history a special hospital was set aside for treatment of injuries of the face by the R.A.M.C. The last war saw the first Canadian plastic surgery unit in action. Today the specialty stands firmly established as part of the art of surgery, broadened and strengthened by the trial and lessons of modern warfare.

"How's Your Imagination?"

HERBERT H. LANK

Vice-President, Canadian Industries Limited, Montreal.

December 15th, 1945.

In the advancement of all kinds of science the faculty of imagination has played an important role. Inventive genius is mainly applied imagination. This faculty was one of the decisive factors in the war, and it is not too much to say that the Allied Nations won because our scientists had the more fertile imaginations.

No branch of science reveals the importance of imagination more than does chemistry. Yet this must be combined with patient and systematic research. There are no miracles in chemistry. There have been great discoveries, and there will be more because with all their skill and diligence chemists have caught only a few facts out of an ocean of possibilities.

As a general rule each new development answers some human demand strong enough to create a market. Nylon offers an excellent example. The appearance of the first pair of nylon stockings on the market in May 1940 marked the culmination of a research and pilot plant development that had taken ten years and an expenditure of ten million dollars. It was the discovery of a brilliant chemist, Dr. Wallace Carothers, and a group of du Pont chemists who in a quest for knowledge regardless of immediate practical value succeeded in rivalling nature in the creation of giant molecules which were later found to be adaptable both to textile fibre and plastics.

Plastics are fulfilling endless needs and only a comparative few of their potential applications have been worked out. But there is no such thing as a universal plastic. Each possesses characteristics to meet a specific need. No one plastic possesses all the virtues. Another recent chemical development which has captured the public imagination is the insecticide DDT, yet that had been found by a Swiss chemist more than 70 years ago and forgotten until 1942 when an urgent military need arose for it.

There are many frontiers of science still to be crossed. They are suggested by a few questions, the answers to which might lead to the foundation of a great new industry. Why is grass green? What makes glue stick? What is starch? What is lignin? What is chlorophyll?

The lecturer displayed and demonstrated a number of samples of new products of science. Among them were a modern hearing aid weighing six ounces, yet incorporating in one case the three-tube amplifier, microphone and batteries; a miniature radio of five tubes no larger than a cigarette case which one may use while walking on the street; nylon stockings of the sheerest knitted fabric ever manufactured; a plate made of nylon which is virtually unbreakable; a nylon bearing which runs without lubrication; a "Lucite" rod which pipes light as metal or glass tubes pipe water; samples of polythene, the lightest plastic known; "Cellophane" ribbon bearing musical recording; and retardent and water repellent chemicals for treatment of textiles.

"Liquid Air—Its Properties, Uses, and Misuses"

JOHN SATTERLY, M.A., D.Sc., F.R.S.C.

Professor of Physics, University of Toronto, Toronto, Ontario.

January 5th, 1946.

The lecturer approached this subject by an explanation of the method of making liquid air and an outline of the uses; leading to a demonstration of unusual reactions which result from its properties. For the latter purpose the lecture platform was equipped with much of the apparatus of the physics laboratory.

Air, under pressure, cooled down to 350 degrees below zero Fahrenheit liquefies and is thus converted into liquid air. This low temperature is obtained by means of compressed air allowed to escape through needle valves and then continuously circulated in coils around the pipes bringing in fresh air to be liquefied. The machine at the University of Toronto is capable of turning out two and a half gallons of liquid air per hour.

The constituent elements in liquid air have different boiling points and thus by fractional distillation it is possible to recover them in the form of gases. Nitrogen is used in the manufacture of commercial fertilizer. Oxygen is used in welding and for medical purposes. In the late war, for the first time, liquid oxygen was employed by aviators flying at altitudes higher than 10,000 feet, it being found that this eliminated the danger of the condensing and freezing of water in narrow tubes which was encountered when oxygen gas made from other sources was used. Other gases recovered from the liquid air plant are helium, neon, zenon, krypton, and argon.

During the war the Department of Physics of the University of Toronto supplied 7,000 litres of liquid air a year to Research Enterprises Limited where it was employed in an ingenious way to create vacuum in radar valves. The principle involved in this operation was that when charcoal was cooled with liquid air its consequent low temperature resulted in such an increase in absorptive power that it drew air into itself, thus exhausting the air from the valves. Another illustrative instance of an unusual use of liquid air occurred at the Chippewa plant of the Hydro Electric Power Commission of Ontario. An accident to one of the generators necessitated removal of the shaft and it was thought that it would be necessary to dismantle the unit at considerable cost. To avoid this, the shaft was filled with liquid air, or rather its nearest commercial equivalent, a mixture of dry ice ($CO2$) with spirits. The resulting contraction made it possible to remove the shaft with comparatively little expense.

At the intensely low temperature of liquid air there occur unusual reactions which the lecturer demonstrated by several experiments. A kettle full of liquid air boiled and "steamed" on a piece of ice. Mercury was frozen into the shape of a hammer and used to drive a nail; also to the form of a hook which supported a 20 lb. weight. Evaporating liquid air sets up a pressure of 12,000 pounds per square inch which was demonstrated by pouring a little into a "pistol" which was then plugged with a cork; the expanding gases popped the cork like a missile a considerable distance. Iron and rubber dipped in liquid air became brittle and breakable; as did eggs, flowers, fruits, vegetables, and goldfish. Many salts, especially mercury iodide, change colour when cooled in liquid air. A large electric discharge tube sign, showing the letters R. C. I., made by the glassblower, Mr. Chappell of the Physics Department of the University of Toronto, was exhausted by the use of a charcoal tube immersed in liquid air and as the vacuum was produced glowed very prominently at the back of the stage. Also was demonstrated the lowering of electrical resistance of metals with decrease of temperature, the magnetic qualities of liquid oxygen, and the combustible nature of cotton waste saturated with liquid oxygen, the last being also illustrated with models of the V-2 bombs, improvised from thin cardboard tubes stuffed with cotton waste.

Finally, as an extra to the main lecture, a demonstration was given of "cold flame." Setting fire to a mixture of two parts of carbon tetrachloride and one part of carbon bisulphide, the lecturer turned up his sleeves, bathed his hands and arms in living flames, and dipping an asbestos rope ring in the solution, he placed a halo of fire upon his head. No damage resulted.

"The Six Nations of Canada"

WILLIAM N. FENTON, A.B., Ph.D.

Senior Ethnologist, Bureau of American Ethnology, Smithsonian Institution, Washington, D.C.

January 12th, 1946.

The Great League for Peace existed among the Six Nations of the Iroquois Confederacy for more than three hundred years after white settlement. Tradition attributes its beginnings to a Canadian Iroquois from the Bay of Quinte, named Deganawii' dah, and to Hayenhwentha (Hiawatha). The two met when they found sanctuary among the Mohawk nation. They had the idea that men should cease murdering men of other towns, and that tribes as well as villages should live by four dual principles: Peace (Health), Righteousness (The Good Word), Civil Authority (Strength), and the League (The Great Law). The two founders set out across New York State taking in one after another, the Mohawk, Oneida, Onondaga, Cayuga, and Senaca tribes, which became the United Nations of the New World, and were governed by a congress of co-equal chiefs who were responsible to the matrons of their families.

The story of the Six Nations of Canada begins conveniently at the close of the American Revolution when the Indians, under Thayendanegea, whom the English knew as Captain Joseph Brant, decided to cast their lot with the Empire Loyalists and migrated beyond the Niagara frontier. They settled on the banks of the Grand River to enjoy "forever" a Crown grant of six miles on either bank from Lake Erie to its source. There they maintained a vigorous nationalism and rebuilt their ancient political edifice—the Longhouse of their pre-Columbian grandsires.

The new confederacy of the Six Nations endured on the Grand River from 1785 until 1924 when the Indian Act proscribed government by Life Chiefs and instituted the elective system. However, the "old council" has a substantial following among the older people, particularly among those families "who walk in the path of the ceremonies of the Longhouse people." It was to friends among the Longhouse people that the lecturer turned in November 1945 for permission to witness the ancient Condolence ceremony and council for installing a Cayuga chief.

The deceased chief was Haga' en' yonk (Abram Charles), who was succeeded by his sister's daughter's son (John Hardy Gibson). The bereaved tribes of the Lower Cayuga Longhouse, known as The Four Brothers, were Oneida, Cayuga, Tuscarora and Tutelo. The Condolers from the Onondaga Longhouse, two miles to the west, known as The Three Brothers, consist of the Mohawk, Onondaga and Seneca tribes.

A procession of the latter, led by a chanting singer calling the roll of the founders of the League, proceeds to the Longhouse of the bereaved tribes. At their approach a small fire is kindled near the gate of the Longhouse. The people of the bereaved and of the condoling tribes line up on either side of the fire, chiefs to the fore, the public behind. A speaker for The Four Brothers paces slowly to and fro chanting measured phrases of welcome with which for centuries grieving tribes had greeted the Condolers: "Great thanks that you have passed safely diverse obstacles and dangers that beset your journey." There follows a symbolic ceremony of Requickening to enable the visitors to see, hear, and breathe freely. This is returned.

Both at the ceremony in the open and later in the Longhouse there pass from the Condolers to the bereaved and back symbolic strings of wampum with each message. After about an hour's ceremony out-of-doors, the visitors are conducted inside the Longhouse where the chiefs occupy two opposite benches placed lengthwise at one end of the house. Here Six Songs are chanted by the visitors. The Hymn of Farewell to the Dead Chief is so sacred to the Iroquois that they will not sanction recordings. "Over the Great Forest," a recitation of the Laws of the League, is given only by the Condolers. The remaining burdens of Requickening, the fourth to the fifteenth, by the Condolers, are again accompanied by the symbolic act of sending strings across to the bereaved; all but one of these are returned when The Four Brothers reply.

The climax of the five hours of ceremonial is the presentation of the candidate for chiefship and his crowning with the symbolic antlers of office.

A terminal feast follows, and a social dance, called "rubbing antlers," carries the festivities well toward midnight.

"Six Years in Canada's Department of Scientific Defence"

C. J. MACKENZIE, D.Sc., D.Eng., LL.D., F.R.S.C.

President, National Research Council, Ottawa, Canada.

January 19th, 1946.

Although there were a number of substantial military projects under way in the National Research Council a few weeks after the outbreak of war, it was in the darkest days when the Germans were overrunning the Low Countries and France that the real foundations of the Council's scientific war activities were laid. In September 1939 this organization had 300 employees and was operating on a budget of $900,000. Within a few years it was supporting a staff of nearly 2,000 and spending nearly $7,000,000 per year and had become associated with nearly every scientific aspect of the war.

As a peacetime organization it had contributed significantly to the scientific life of Canada during the preceding two decades by awarding scholarships and giving grants to university professors to aid research thus helping to build up a corps of young scientists who were later available for war work. When war broke there was in operation one National Research Laboratory. During the war twenty-one other laboratories, some small and temporary, others large and permanent, were established. These included temporary laboratories for cold weather work at Lake Louise, Jasper, Edmonton, Saskatoon, and Winnipeg, an explosive experimental station at Valcartier, large laboratories in Montreal and Chalk River in connection with the atomic energy plant, radar laboratories near Ottawa, naval research stations on both coasts, and a permanent group of nine buildings and wind tunnels for aeronautical and engineering research.

In addition, practically every laboratory in Canada offered its facilities to the government, and these laboratories and staffs were welded into an informal but highly effective co-operative association. Under the auspices of the Council, twenty major associate research committees with nearly 100 sub-committees directed the scientific program in as many broad fields of war research. Liaison offices were opened in London, Washington, and Ottawa, and through these channels flowed freely intelligence and reports on all the secret projects being worked upon in the three countries.

While Canada never had any scientific research organization associated with the Department of National Defence, General McNaughton, when he became president of the National Research Council in 1935, fore-

seeing the inevitable conflict, began within definite budgetary restrictions to initiate some work, and it is greatly to his credit that every project started at that time subsequently developed into a major contribution. General McNaughton and the late Sir Frederick Banting above all others influenced our earliest scientific activities after the outbreak of war.

Shortly after the fall of France two things happened that influenced most profoundly our contribution to the war. The British sent to Washington a scientific mission headed by Sir Henry Tizard, and a few patriotic Canadians offered to the Government as a gift approximately $1,300,000 to be used for the prosecution of the war. The timing of these two isolated occurrences profoundly affected the course of our scientific effort. This British mission disclosed confidentially to representatives of the United States and Canadian governments Britain's experience in the development and use in combat of scientific devices; and also a long list of proposals that were still in the "idea" or early development stage.

From the Tizard mission Canada obtained much first-hand information and advice about scientific warfare and the problems which needed attention. It was about this time that the War Technical and Scientific Development Committee was formed to administer the fund of $1,300,000 donated by private citizens. With this it was possible to start work immediately on any problem without further reference. The first day the fund was made available sixteen projects were accepted immediately for which $262,700 was allotted. Most of them grew from a modest start into very large and successful enterprises. As a result it was possible to get on with months of valuable planning and investigations before official acceptance of and financial support for a project could be obtained.

In March, 1939, one lone scientist, Dr. John Henderson of the National Research Council, went to England on the invitation of the Air Ministry and was given all the information about radar, the secret device for detecting aircraft. He was then the only man on this continent who was in on the secret. By late winter one crude set had been designed as part of the first defence works at Halifax; this was the first operational set on this continent. From then on progress was rapid and by the end of the war Canada had designed thirty different types of equipment. Radar equipment to a gross value of three hundred million dollars was designed in Canada and built by Research Enterprises Limited. The proximity fuse was a suggestion brought over from England by the Tizard mission on which a group at the University of Toronto did valuable early work under Dr. Arnold Pitt and later co-operated with the United States Navy group who turned it into a working reality.

In addition to radar and the proximity fuse there were scores of other major achievements like those in medicine, which were outstanding; in

aeronautical engineering; in the chemistry of supplies and substitutes; in biological warfare; in tropicalization of our equipment for use in jungles; in protective clothing; in nutrition; in packaging and transportation of foods; and a host of others, to say nothing of the innumerable smaller devices developed and of the many wonderful projects that were stillborn.

Quite apart from the international, national, and practical aspects of atomic research Canada obtained something it never had before—the opportunity to march in the front line of physical research. At Chalk River it has the most advanced and only nuclear research equipment of its kind to be found anywhere in the world outside the United States, and if we are wise and farseeing in our universities and public institutions we can build up in Canada a national nuclear research activity equal in quality to that found anywhere, and that is an opportunity which Canada must not forget.

"Industry, Architecture, and Design"

SERGE CHERMAYEFF, F.A.I.A., F.R.I.B.A.

Professor of Architecture, and Chairman of the Department of Design, Brooklyn College, Brooklyn, N.Y.

January 26th, 1946.

Many people of our age are amused by the overstuffed and over-decorated fashions of an earlier generation. Yet much of our modern design exhibits, in principle, the same mistakes in taste. This fault is reflected chiefly in a tendency towards redundancy and a failure to harmonize function and appearance. For example, a pencil sharpener, for no aesthetic or practical reason, may be given a so-called "streamline" design; or a radio be concealed behind false bureau drawers.

These attempts to conceal the true nature of objects amount to a fetishism and are irrelevant to either taste or function. They serve mainly the interest of selling and might be called "the millinery principle" in design intended to catch the buyer's eye and fancy.

In modern design there are two notable exceptions to these errors; the telephone and the typewriter. Both have evolved a pleasant form by a strict adherence of design to function.

These faults in taste derive to a large extent from an age which was characterized by what has been called the idea of conspicuous consumption expressed in over-ornate whatnots, overstuffed furniture, and a generally baroque pretentiousness.

Improvement might be looked for by designing objects as instruments for use, thus giving the public an opportunity to develop a criterion of taste from a sound basis. The aim should be a creative integration of function, technology, and form into organic designs in the manufacture of furniture and other instruments of living.

This principle should also be applied on a larger scale in community planning and housing. Housing is one of the greatest of present needs, yet it is being served by the most obsolete industry. It is to be hoped that housing units such as kitchens, bathrooms, sleeping, and dining rooms may be manufactured in specialized factories off-site and merely assembled on-site.

"Hormones and Horticulture"

GEORGE S. AVERY, Jr., M.S., Ph.D.

Director, Brooklyn Botanic Garden, Brooklyn, N.Y.

February 2nd, 1946.

Plant hormones are organic acids existing in minute quantities in the tissues of all plants. Formed in one part of a plant, they move at the rate of about an inch an hour to all other parts, where they regulate growth and metabolism in a way somewhat similar to the action of hormones in the human body. Depending on their concentration and the tissues they are present in, they promote, retard, or destroy growth.

Hormones were originally isolated chemically at the University of Utrecht in 1932. First synthesized in laboratories in 1936, a vast field and manifold uses have since opened up for synthetic hormones; a chemical revolution in agriculture is already one of the outcomes of their discovery.

One new synthetic hormone (2, 4-dichlorophenoxyacetic acid) has a number of different uses, depending on the strength at which it is employed. In a weak solution, one to ten parts per million (ppm), it produces seedless tomatoes. At five to ten ppm it increases the size of pineapples as much as twenty-five per cent. Properly used, it hastens by several weeks the period of fruit production in pineapples. At ten to one hundred ppm it speeds the rooting of cuttings, and at one thousand ppm it destroys certain kinds of plants but not others—a more or less selective capacity to kill is therefore one of its characteristics.

In our agricultural economy the selective weed-destroying properties of synthetic hormones is already of great importance, as weeds cost the American farmer, in crop losses and control expenses, some three billion dollars annually. As an example of its selectivity: when sprayed on a lawn at a proper strength it will destroy such common lawn weeds as dandelions, plantain, etc., roots and all, leaving the grass undamaged.

Still another quality is of interest and significance: certain fruits picked green and firm will, after spraying, ripen quickly.

Other synthetic hormones are useful also: blossoms on apple trees can be thinned, and the growth of roses and other plants held back more or less as desired. Potatoes can be prevented from sprouting in storage, and the premature dropping of apples and pears can be controlled.

As an illustration of this new potential power in promoting growth, about four pounds of synthetic hormone concentrate would obviously and visibly influence the growth of a row of plants stretching a distance equalling that from earth to sun.

Hormone research is being actively continued, and should eventually lead to increased plant growth control with subsequent benefits to farmer, nurseryman, fruit grower, and home gardener. Such benefits are bound to be reflected in a more prosperous economy.

"Electronics in War and Peace"

J. T. THWAITES, B.Sc.

Division Engineer, Electronics Division, Canadian Westinghouse Company, Limited, Hamilton.

February 9th, 1946.

Probably the most spectacular military developments in electronics were in the field of communications. But the work of the industrial electronic engineers was important to the war effort; and it is hoped that the applications of their discoveries and techniques in peacetime will be manifold.

Some examples of the industrial uses of electronic devices follow.

The Ignitron, an electronic tube, is used in converting alternating current of the regular power systems to direct current for the electrolysis

and reduction of aluminum and magnesium. All the aluminum used during the war, and a considerable part of the magnesium, was produced electrolytically. This method bolstered Canada's output of aluminum to the Allied Cause by over two million pounds per day. Another war-time use of the Ignitron rectifier was the production of hydrogen, necessary in the manufacture of explosives. Tons of hydrogen a day were produced electrolytically. With the coming of peace, the demand for Ignitron rectifiers has not ceased, especially for transportation systems in cities and towns. The Ignitron tube is also used as a control tube for seam and spot welding, making welds at the rate of 16 to the second and with less than one defective weld in three millions made.

Radio frequency heating has been an important development. By this method material is instantaneously impregnated with heat throughout its mass. Thus it is not necessary to overheat material at its surface in order to raise the temperature at deeper levels. During the war it was used in the manufacture of extremely large amounts of plywood required by the various services and we forsee a continuation of this demand. It reduces the time for certain operations from hours to minutes.

Electronic inspection devices came to the fore during the war in connection with the inspection of a multiplicity of small parts which were required to be as close to exact twins as possible. Working on a photoelectric principle these devices could detect pinhole flaws in steel sheets moving at 1,200 feet a minute and make a mark so that further operators might reject the piece. They can even be arranged to shear out the piece and reject it automatically.

The mass spectrometer operating on an electronic principle can analyze complex mixtures in a matter of minutes where physical or chemical separation would take days. Another tool which is of extreme importance in inspection is the Super-Sonic flaw detector, based on a principle similar to Radar. It has detected flaws so small that a 200 times magnification by the microscope has been necessary in order to locate them visually.

Important peace-time uses will probably be found for electronic air cleaners or electrostatic precipitators. This device involves the ionization of the most minute dust particles in the air which are then attracted to a pair of electric plates. Air cleaners of this type are being supplied in increasing numbers to industrial processes where dust is a hazard; to automatic switchboards of telephone exchanges where a particle of dust falling on a contact will cause improper operation; and to sleeping rooms for hay fever patients. A wider field for application of electronic precipitation may be in abating the smoke nuisance.

"Plywood and its Future"

W. CZERWINSKI, M.E.

Chief Engineer, Canadian Wooden Aircraft Limited, Stratford.

February 16th, 1946.

Veneer, which is a thin sheet of wood used in making plywood, has been found in the tomb of a king of ancient Egypt of thirty-five centuries ago. It was used by Chippendale in the 18th century and by Riesener in making the famous "Cabinet of the King" for Louis XV.

Recently developed techniques, however, promise an expanded use of plywood beyond anything in the past.

Plywood consists of three or more layers of thin wood, or veneer, glued together and having the grain of alternating layers running at right angles to each other, thus imparting great stability and strength. The discovery of certain synthetic-resin glues has opened a new era in the technology of the industry. Some of these synthetic-resins are efficient not only in bonding wood to wood, but also wood to plastics, metals and other materials.

The synthetic-resins have made possible the application of hot presses to plywood, cutting down the time of manufacturing from some days to a matter of minutes.

The modern resin-bonded plywood has important advantage in the manufacture of aircraft, boats, furniture, and different kinds of containers (which now have plastic linings). Small water and aircraft will probably be made almost exclusively of plywood in the future.

Plywood gives a much larger yield than lumber and strict economy is needed in all use of forest resources. It is obtained from trees by a method radically different from sawn lumber. The device used is the rotary cutter. The log is rotated against a knife which shaves off wood to a desired thickness, unwinding veneer which is cut later into the proper sizes; thus the ribbons of wood shaved or peeled off the rotating log are later dried in steam heated driers, spread with glue and pressed into plywood.

Probably the greatest future of plywood lies in the construction of pre-fabricated houses. The new synthetic-resins make it resistent to moulds and fungi and it can also be treated for fire resistance. In the new cities built in the United States for war industries, pre-fabricated

houses were constructed mostly of plywood. The walls consisted of two sheets of plywood set about three inches apart, the intervening space being filled with rock wool. This arrangement gives insulation equal to a wall two feet thick made of brick.

"The Human Equation"

HENRY G. WEAVER, B.Sc.

Director, Customer Research Staff, General Motors Corporation, Detroit, Michigan.

February 23rd, 1946.

In industry it might truthfully be said that the human equation for the most part centres around the customers. Just as the physical laboratory concerns itself with the qualities and behaviour of physical things in relation to problems of design and production, customer research concerns itself with the psychological attitudes and reactions of human beings, not only as regards questions of product and design, but as regards the services, policies, and procedures surrounding the sale and use of the product.

In a very small business the close contact with the consumer assures an intimate knowledge of his needs, tastes, and desires more or less automatically and without conscious effort. But as a business grows in size and becomes more highly departmentalized, it is necessary to set up systematic procedures designed to bridge the gap between the ultimate consumer and those responsible for guiding the destiny of the business.

What the customer will stand for today counts for more than ever before. It has been said "The customer is always right." This is not necessarily true. He is human like everyone else and makes mistakes. But as a general principle it is the part of wisdom to find out what people like and do more of it; to find out what people do not like and do less of it.

The customer research of General Motors since 1932 has, in line with this principle, sent out more than thirty million questionnaires to motorists. The replies have constituted what might be called the "vitamins of human understanding." Our files are illuminating especially in the letters accompanying the returned questionnaires and these must be read between the lines to discern their true revelation of the human equation.

Progress in the realm of physical things is far ahead of progress in the science, or rather the art, of human understanding. Greater progress and a more enduring prosperity would surely be ours if, throughout all phases of modern business, we might get a better understanding of human

beings. Human understanding is the important thing, and consumer research, be it by means of sending out questionnaires, calling on people, etc., is merely one of the tools used.

"Map Making for War and Peace"

W. E. WRATHER, Ph.B.

Director, United States Geological Survey, Washington, D.C.

March 2nd, 1946.

During the last war it became evident that available maps were woefully deficient in number, in degree of accuracy and in detail to meet the exacting requirements of modern technologic warfare. Maps and charts were needed for almost every part of the world, wherever there was even a remote possibility that military or naval operations might take place.

The scope of such an assignment was without precedent and was further complicated by the factor of time. This necessitated the development of new techniques almost overnight; and of all the scientific and technologic innovations born of war necessity none will be more readily adaptable to meet the needs of a peaceful world.

The combined output of Great Britain and the United States probably approximated 100,000 different assignments and the total number of copies of maps ran to around a billion, requiring the full time services of some 35,000 surveyors, draftsmen, and allied technicians. Special expeditions were promptly outfitted and dispatched to the farflung corners of the earth to secure special geodetic information. They utilized every known means of transportation including native porters, camels, yaks, river boats, motor vehicles, and even parachutes. They were supplied with radio, radar, and portable astronomic instruments to establish exact latitude and longitude positions in localities many of which had never been seen on the ground by white men. Thus a geodetic control grid was completed to meet basic wartime mapping requirements throughout the world excepting only a part of the South Polar region.

Trimetrogon photography from airplanes was adopted. By this method a battery of three cameras with synchronized lenses takes simultaneous overlapping pictures giving a photographic strip extending from horizon to horizon. By these new techniques of photogrammetry vast areas throughout the world could be mapped by personnel who had never seen the territory. One mapping unit employing approximately two hundred persons produced aerial navigation charts covering some two million

square miles of territory within a period of six months. These aerial navigation charts will be continuously useful for many years to come.

A method was worked out for making molded relief maps on sheets of Vinylite plastic. This new and cheap method of making relief maps will undoubtedly be applied to many peace-time uses in education, community and regional planning, land utilization, and other fields of activity. Detailed geologic map coverage in Europe, Japan, and many other parts of the world far exceeds the coverage in the western hemisphere, a handicap both in planning military defense and in peace-time economic development. Of the most promising war-developed techniques in mapping, the chief is electronics, by which it is possible to measure distances of 200 to 300 miles with the speed of light and with an error of no more than 15 feet.

"Radio and Culture"

ARTHUR L. PHELPS

Supervisor, United Kingdom and Commonwealth Broadcasts, Canadian Broadcasting Corporation, Montreal.

March 9th, 1946.

Radio is a sort of spiritual nuclear energy with power to destroy us or serve us. As in the case of nuclear energy, the power is in our own hands. In relating it to culture, it is necessary to realize the present trends towards a breaking up of local and regional cultures, a process which is apt to frighten us. The trouble is we are literally "between two worlds, one dead, the other waiting to be born." In truth the only self-preserving society now possible to us is a world society, but our technical and imaginative adjustments are not developed.

Any topic which through the word culture or otherwise pretends to touch on our life of the mind and spirit today must measure itself against the magnitude of our common jeopardy. Cultures change and new cultures emerge. We are on the edge of a world culture and must learn how to rise to it or we shall die. We face a wholly new environmental problem in adjustment to a self-preserving and agreeable way of life.

Radio is producing certain results which have a bearing on our changing culture. It is the responsibility of all citizens to accept radio as one of the major conditioning influences of our time, to study it, to watch it, to safeguard great human uses for it.

Consider it under some of the normal categories into which its services divide themselves. Take first radio as entertainment. There is to a certain extent the calculated appeal to presumed soft emotions and flaccid minds of the audience. If there is a delighted and uncritical public for such entertainment, the fact is surely a challenge to our whole educational, religious, and social milieu and a standing rebuke to those who would exploit it without misgiving. This is not the whole story regarding radio entertainment. There are symphony concerts, the forums, drama and good talk. The ratings on which advertisers so largely rely have been coming under a good deal of scrutiny and there is the suspicion that the advertisers themselves have eliminated as listeners those sections of the public whose taste might be discriminating.

In the field of instruction, radio serves well its purpose as a nutrient medium in the interest of public cultivation. This includes the forums which may bring back the art of good conversation; farm broadcasts; craft and professional shop talks; school broadcasts.

The organization and release of news has become a prime function of radio. Increasingly it demands not only trained voices, but trained minds at the microphone, sensitive to words and phrases, their explicit and implicit connotations, and the whole rythm of objective, clear, responsible utterances. There lurks here, of course, the whole matter of slanted, censored, and omitted news, which in one way or another can make of the newscast an instrument of propaganda and of the radio other than a nutrient medium for the mind of man.

In art, radio has a high aesthetic importance.

For radio, as for nuclear energy, we must create a wise human custody. It needs the control of the conditions of its freedom which may best be achieved by the regularly exercised votes of alert and concerned citizens who, operating through the processes of a democratic parliamentary system, demand that their government keep their radio intelligent and alert.

"Electronics in Music"

CAREY W. BAKER, B.Sc., E.E.

Chief Engineer, English Electric Company of Canada Limited,
St. Catharines, Ontario.

March 16th, 1946.

Throughout history various sciences have from time to time contributed to the advancement of music. The metallurgists have provided better materials for musical instruments. The physicists have extended understanding of how sound is produced and carried through air and of the underlying principles of acoustics, which have enabled architects to design better auditoriums. By setting up a reasonable standard of vibration-frequency for the notes of the musical scale, the physicists have helped to unify music throughout the world, making it a more perfect and universal language. The instrument manufacturers have applied scientific principles in design.

And now the electronic engineers are turning their efforts towards the production of music. These efforts have been sadly interrupted by the necessity of developing and building so many electronic devices for war, but such engineers have given and are giving a large contribution to the musical world of peace. They have given us a new group of musical instruments with characteristics distinctly different from the familiar wind, string, and reed instruments, and have given us new methods of control that can produce musical effects not previously obtainable.

There are three basic principles upon which electronic organs may be built—electro-dynamic, electrostatic, and electronic.

In the electrostatic principle the sound vibrations are caused in the old way by wind on reeds which are then picked up, mixed, and amplified electrically, producing effects which could not otherwise be obtained. In the electro-dynamic principle the sound vibrations originate in generators in the instrument controlled by the keyboard. The Novachord is a strictly electronic instrument and a completely new element in music. The vibrations originate electronically and are transmitted from the keyboard to the loud speaker with the speed of light. The mixtures of frequencies produce harmonic curves that may imitate older instruments or may cause entirely new effects, its versatility being limited only by the player's dexterity and ten fingers.

Some musicians frown on the development of electrical musical instruments. And yet Sigmund Spaith, the well-known composer and critic,

says of the Novachord that it is a most interesting and versatile instrument and that he is pleased to have it in his studio.

The results may go far beyond known sound effects to effects that have not yet been explored musically and are yet unknown to composers. Thus a whole new field may be opening up in musical composition.

"Microwaves in Radar and Communication"

W. H. DOHERTY, S.B., S.M.

Radio Development Engineer, Bell Telephone Laboratories Incorporated, New York, N.Y.

March 23rd, 1946.

During the war there has been a tremendous extension of the frequency range of radio waves. Before the war broadcasting involved radio waves of hundreds of metres in length. Later short-wave broadcasting brought the wave length down to metres in length. The so-called microwaves are measured in centimetres of length.

This accomplishment was brought about by an outstanding example of British and United States scientific co-operation in the war effort and its results are likely to have important extensions into the post-war world.

Microwaves are measured in megacycles which is a unit of a million frequencies per second. One of the great difficulties in developing waves so small had always been that the interior dimensions of the vacuum tube must be smaller than the wave length in order to get the requisite power. This problem was solved by an English scientist who invented the "Cavity Magnetron." Early in the war a model of his device was brought to the United States for mass production. Results in the scientific war were beyond calculation.

The great advantage of microwaves is that they permit a high degree of discrimination in picking up images. They can be beamed like a searchlight and will give a detailed picture of objects on the radar screen.

Although its use was most spectacular in aerial warfare, enabling fighter planes to track down and shoot down enemy planes, the microwave principle in radar played an important part also in the gun director and in submarines. United States' submarines during most of the war always used radar even in daylight. It provided range measurements

superior to anything possible with a periscope, giving accuracies to the order of one ten-millionth of a second, representing about 20 yards. Radar on ships was invaluable as a defence against Japanese suicide planes.

Peace uses of microwaves are already being explored by the Bell Telephone Company. They may soon replace wire lines and rival the broad-band coaxial cable in carrying multi-channel long distance telephone conversations and for television transmission. Microwave relay transmission towers are being constructed on seven hill-tops between New York and Boston. The hills give greater height and are needed because the waves do not follow the curvature of the earth and must be received for relay within the limits of the horizon.

So transmitted, the microwave bands may carry hundreds of long distance telephone conversations simultaneously, but only one or two television broadcasts. Television requires a thousand times as much room on a frequency band as speech.

"Gliders and Gliding"

B. S. SHENSTONE, M.A.Sc., F.R.Ae.S.

Technical Adviser to the Minister of Reconstruction and Supply, Ottawa, and President of the Soaring Association of Canada.

March 30th, 1946.

Gliding is many different things: a sport, a hobby, a study, a science. To glide is to fly without an engine. With a knowledge of the power of the atmosphere it is possible, as well as to glide downwards, to soar upwards as if in defiance of gravity. In gliders men have soared to thirty thousand feel altitude, stayed aloft for two days and two nights, and flown 500 miles in a straight line.

The glider designers' efforts are directed towards making its sinking speed as low as possible. It is possible to reduce it to as low as two feet per second for a glider weighing 800 pounds. Therefore, as long as there is a wind whose upward component is at least two feet per second, the glider will maintain height. The updrafts near a hill with the wind blowing against it are especially efficacious in sustaining a glider, and hill soaring is the simplest in principle, but not easy in practice. It requires great patience, an unusual knowledge of the vagaries of the winds, exceptional pilotage, and a wide extent of rough, hilly country like the Laurentians or the foothills of the Rockies.

For a time the riding of thunderstorms was very popular and special techniques were evolved. Pilots report that the panorama from the front of a thunderstorm is absolutely magnificent. On one side the sunny earth far below, and on the other the black, milling clouds twisting about, the whole creeping over the earth and putting it in shadow.

Then there is the joy of riding the "streets" of cumulus clouds. Hundreds of miles have been covered in this manner by skilled pilots. The helm waves in the lee of high hills or mountains have provided the upcurrents of air that are used in very high altitude flying. As a sport the appeal of gliding is akin to skiing and sailing. The pilot is truly flying the machine, not merely guiding a powered monster through the air. In one respect it is like swimming as contrasted to roaring through the water in a motor boat. There is the attraction of developing further skills such as knowledge of upcurrents and the ability to take advantage of certain types of clouds, thunderstorms, and ranges of hills. It is never boring. Each flight is different.

It is a science and education giving one an intimate knowledge of the air, creating an awareness of its movements, of the causes of weather, a true air-mindedness. It encourages design and development of gliders and sailplanes thus increasing knowledge of aerodynamics.

It is like any other scientific development, the more you do the more you learn; and you cannot forsee what you will learn.

Canadian efforts in gliding are in a very early stage. A number of things are needed: a gathering of people interested in gliding; more gliders and a good co-ordinating body, so that scattered groups can be kept completely up-to-date with progress.

Membership.

(1) Ordinary members are entitled to all privileges of membership, the annual fee being five dollars. Applications for ordinary membership are passed upon at the regular meetings of the Institute.

(2) Associate members are ladies who do not desire full membership. They are admitted in the same way as Ordinary members, the annual fee being two dollars and fifty cents.

(3) Life members are elected in the same way as Ordinary members, the Life membership fee being one hundred dollars.

For further information relating to membership or to the activities of the Institute, address letter to

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Armstrong, Rev. R. A.
Arscott, A. E.

A—Continued.

Ashworth, E. M.
Ashworth, F.
Askin, R. J.
Atkinson, C. J.
Atkinson, J. E.
Attridge, E. F.
Austin, Alan
Avtzine, Anatole D.
Aykroyd, M. J.
Aylwin, A. A.
Aylwin, Arthur

B.

Baer, Prof. E. F. T.
Bailey, Prof. D. L.
Baillie, Prof. W. H. T.
Bain, H. R.
Bain, Prof. J. Watson
Baird, G. R.
Bairstow, E. J.
Bakelite Plastics Division, Carbide & Carbon Chemicals Ltd.
Baker Advertising Agency Ltd.
Baker, E. G.
Baker, Eric W.
Baker, Geo. A.
Bales, Gerald
Balfour, Gordon B.
Banbury, T. R.
Band, C. S.
Banfield, A. W. F.
Banner, Mac
Barber, Frank
Barber, George
Barlow, Hon. Mr. Justice F. H.
Barrett, Henry
Bartlett, A. A.
Bascom, J. M.
Batkin, P. J.
Bayes, C. W.
Bayes, Mrs. C. W.
Beacock, V. A.
Beamish, Prof. F. E.
Beatty, Prof. Samuel
Begg, Evan A.
Begg, Herbert Bruce
Behrns, Miss Myrtle
Bell, Adam
Bell, F. J.
Bell, J. R.
Bell, R. Norman
Bellak, Rudolph
Bennett, A. Guy
Benson, G. C.
Benson, W. R.
Beringer, M. S.
Berkinshaw, N. W.
Berkinshaw, R. C.
Berner, G. T.
Berry, Dr. A. E.
Bertram, H. Graham.
Best, Dr. C. H.
Betts, D. C.
Bickersteth, J. B.
Bickerton, A. J.
Billes, J. W.
Birks-Ellis-Ryrie Ltd.
Birks, R. T.
Bishop, Col. Arthur L.
Bishop, H. H.
Black, G. M., Jr.
Black, W. Howard
Blackhall, Wm. E.
Blackwood, Major S. Temple
Blair, F. J.
Bliss, Dr. H. C.
Boeckh, John C.
Bogart, Ernest C.
Bogert, Clarence A.
Bolton, N. E.
Bond, R. B.
Bongard, Gordon R.
Bongers, Harry
Bonn, W. E.
Bonney, Robert
Booth, J. M.
Borchardt, Dr. Curt
Bosley, W. H.
Boswell, Prof. M. C.
Box, Dr. Harold K.
Boyd, A. G.
Boyd, Dr. Edmund
Boyd, Dr. William
Boyer, Dr. George F.
Brace, Dr. A. J.
Brace, G. A.
Bradley, Norman W.
Bradshaw, A.
Brady, J. M.
Braund, H. C.
Brennan, A. C.
Brewer, H. B.
Bridgland, M. P.
Brierly, J. P.
Briggs, Wilmot S.
British American Oil Co. Ltd.
Britnell, Robert C.
Broadhurst, T.
Brock, J. W.
Brock, S. G.
Brodigan, F. H.
Brodey, Draimin & Co.
Bromo-Seltzer Ltd.
Bronstein, David
Brooks, Lee R.
W. A. Brophey Co. Ltd.
Broughton, Dr. E. A.
Brouse, W. H. D.
Brown, Henry
Brown, Linwood L.
Brown, R. G.
Brown, Roy
Brown, S. C.
Brown, Dr. W. T.
Browne, F. W.
Brownscombe, M.
Bruce, D.
Bruce, Dr. H. A.
Bryce, Robt. A.
Buchan, John E.
Buchanan, Dr. M. A.
Buffam, Dr. B. S. W.
Bulbeck, Arthur A.
Bull, George N.
Bullock, G. F.
Bunnell, A. E. K.
Burgar, Wm. J.
Burgess, C. R.
Burgoyne, J. S.
Burk, Prof. J. D.
Burke, E. T. C.
Burns, H. D.
Burton, A. G.
Burton, A. S.
Burton, C. L.
Burton, E. G.
Burton, Eugene C.
Burwash, Dr. E. M.
Robert Bury & Co. (Canada) Ltd.
Business Systems Ltd.
Butler, Albert
Butler, W. C.

C.

Cameron, A.
Cameron, Dr. Gordon C.
Cameron, Dr. Malcolm H. V.
Campbell, Dr. Angus A.
Campbell, C. J.
Campbell, Dr. Colin A.
Campbell, Colin A.
Campbell, D. H.
Campbell, G. H.
Campbell, Gordon P.
Campbell, Dr. James A.
Campbell, L. S.
Campbell, R. O.
Campbell, W. A.
Campbell, Walter F.
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Canada Cycle & Motor Co. Ltd.
Canada Packers Limited
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Canadian Breweries Ltd.
Canadian Industries Ltd.
Canadian Kodak Co. Ltd.
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Canadian Line Materials Ltd.
Canadian Toledo Scale Co. Ltd.
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Carlisle, F. K.
Carman, George
Carnation Company Limited
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Carr, Dr W. R.
Carrington, Frank R.
Carruthers, George
Carruthers, G. L.
Carruthers, W. R.
Carson, C. E.
Carson, J. L.
Carter, A. Hiles
Cartwright, J. R.
Carveth, Walter A.
Cassels, R. C. H.
Cassidy, H. F.
Cates, Dr. H. A.
Caudwell, Norman S.
Caven, Dr. W. R.
Cawthorne, F.
Chamberlain, K. W
Chant, Prof. S. N. F.
Chantler, W. E.
Chapman, G. B.
Chapman, R. E.
Charles, Leo E.
Cheesman, C. Herbert
Chisholm, G. T.
Chubb, F. W.
Churchill, T. C. D.
Clark, Francis W.
Clark, R. S.
Clarke, Eric
Clarke, H. W.
Clarke, Irwin & Co. Ltd.
Clarke, K. H. J.
Clarke, Ross
Clarke, Miss S. H.
Clarkson, F. C.
Clayton, Harry E.
Clements, Charles
Cleminson, Leslie
Cleverley, A. C.
Cline, George A.
Clipsham, K. M.
Coatsworth, Emerson T.
Cockburn, Prof. J. Roy
Cockburn, Laurance
Cockeram, A. H.
Cockeram, Alan
Cody, The Hon. Rev. Dr. H. J.
Cohen, Arthur
Cohen, J. S.
Cohen, Perce
Colberg, A. M.
Cole, Dr. C. E. Cooper
Cole, Dr. Frank L.
Colebrook, H. G.
Colgrove, R. G.
Colville, John H.
Conant, Dr. Gordon D.
Connell, F. M.
Cook, James
Coombs, F. J.
Coon, H. A.
Coon, H. J.
Cooper, Eric
Cooper, H. G.
Cooper, N. R.
Copp, Dr. C. J.
Corbett, H. Milton
Cork, J. Milton
Cork, Justin M.
Corless, Dr. C. V.
Corrigan, Dr. C. A.
Corrigan, Fred S.
Corson, Rolph R.
Cosgrave, Rev. Dr. F. H.
Costello, James B.
Costigan, James P. McD.
Couch, Dr. J. H.
Couke, J. H.
Coutts, Wm. E.
Coventry, Prof. A. F.
Cowan, H. M.
Cowie, Hedley V.
Cox, A. H.
Coyne, Gordon B.
Craigie, D. E.
Craigie, Prof. E. Horne
Crang, J. H.
Crase, George H.
Crawford, J. K.
Crawford, Dr. J. S.
Critoph, Dennis
Crockett, Edwin
Crossgrove, George M.
Crossingham, John H.
Crown Cork & Seal Co. Ltd.
Cruickshank, C. W.
Cunningham, Dr. J. G.
Currelly, Prof. C. T.
E. & S. Currie Limited
Currie, T. D.
Cutten, Arthur F.
Cutten, R. J.

D.

Dack's Shoes Ltd.
Dadson, Dr. A. S.
Dale, George T.
Dalglish, K. C.
Daly, R. A.
Danks, Cyril N.
Darker, Dr. Grant D.
Darroch, Franklin W.
Dauphinée, Dr. J. A.
Davidson, H. T.
Davidson, M. R.
Davies, G. Fay
Davies, Dr. T. Alexander
Davis, Aubrey
David, Bertram N.
Davis, C. B.
Davison, A. E.
Day, Major Bernhard
Daykin, E. Brooke
Deacon, R. D.
Deadman, Dr. Wm. J.
Dean, Clayton D.
Defries, Dr. R. D.
Delahey, W. A.
De La Hooke, E. A.
Delamere, R. D.
DeLury, Prof. A. T.
Dempster, James C.
Dennis, R. M.
Dennis, Mrs. R. M.
Dent, A. E.
Dent, Charles R.
Denton, W. H.
Despard, W. H.
Detweiler, Dr. H. K.
Devitt, O. E.
Devlin, Chas. D.
DeWitt, H. N.
DeWitt, Prof. N. W.
Dick, Dr. John J. M.
Dickenson, J. G.
Dickey, A. J.
Dickson, Miss J. G.
Dignam, Hugh M.
Dixie Cup Company (Canada) Ltd.
Dobbs, Gerald G.
Dobson, Wm. P.
Domelle, J. H.
Dominion Dental Co. Ltd.
Dominion Envelope Co. Ltd.
Dominion Wheel & Foundries Ltd.
Donovan, B. J.
Donovan, Geo. R.
Doran, Jas. P.
Dorfman, A.
Douglas, C. L.
Douglas, H. R.
Douglas, J. S.
Douglas, Wm. E.
Dowsett, R. E.
Dowsett, T. H.
Draimin, Charles
Drew, Charles J.
Drinkwater, Chas. O.
Drury, Dr. C. W.
Dudycha, Frank J.
Duff, F.
Dunbar, Prof. W. B.
Duncan, J. S.

D—Continued

Duncan, John W.
Duncan, S. F.
Duncan, W. A.
Duncan, William
C. A. Dunham Co. Ltd.
Dunham, Lt.-Col. F. H.
Dunkelman, J. B.
Dunlap, D. Moffatt
Dunlap, Mrs. D. Moffatt
Dunlop, Robert J.
Dunlop, Robert S.
Dunlop Tire & Rubber Goods Co. Ltd.
Durland, D. C.
Dyer, Joseph W.
Dymond, Prof. J. R.

E.

Eadie, Arthur H.
Eadie, T. W.
Earl, Ralph V.
T. Eaton Co. Ltd.
Ebbs, Dr. J. Harry
Edmonds, C. E.
Edmonds, G. E.
Edmonds, Dr. L. C.
Edwards, A. Geoffrey
Edwards, A. H.
Edwards, C. A.
Edwards, John W.
Elborn, H. E.
Elliott, Miss Ellen
Elliott, Frank Wallace
Elliott, Dr. G. G.
Ellis, C. Q.
Ellis, M. T.
Ellis, Prof. O. W.
Ellsworth, A. L.
England, C.
Epstein, M. H.
Erb, Dr. I. H.
Erichsen-Brown, F.
Erwin, Harold B.
Evans, U. M.
Evans, W. H.
Everatt, R. A.
Ewens, Wm. S.
Exide Batteries of Canada, Ltd.

F.

Fabian, L.
Max Factor & Co.
Fairhead, H. J.
Fairty, Irving S.
Fallis Dr. A. Murray
Famous Players Canadian Corporation Ltd.
Fardoe, H. R.
Farley, W. A.
Farmer, Colin S.
Farrar, Dr. C. B.
Fear, S. Lorne
Feavyear, Glenn
Fee, Wm. T.
Fennell, A. B.
Fennell, Robert
Ferguson, G. M.
Ferguson, Prof. John Bright
Fidlar, Dr. Edward
Field, Miss M. E.
Finnie, Mrs. W.
Finnie, W.
Firestone, Harold
Fischer, Prof. H. O. L.
Fisher, J. Taylor
Fisher, J. W.
Fisher, Kenneth C.
Flavelle, Sir Ellsworth
Fleming, Donald M.
Fleming, G. O.
Fleming, Murray P.
Fletcher, L. K.
Fletcher, S. S.
Flood, A. J.
Fockler, E. K.
Forbes, H. M.
Ford, I. W.
Forgan, D.
Forsyth, A. L.
Foster, A. R.
Fowler, N. W.
Fox, Miss E.
Fox, E. C.
Frame, J. T.
Frankel, Roy H.
Franks, Dr. W. R.
Fraser, Dr. Chas. G.
Fraser, Dr. Donald
Fraser, John A.
Fraser, J. Ross
Fraser, Miss Margaret A. M.
Fraser, W. Kaspar
Fraser, Mrs. W. Kaspar
Frawley, Dr. D'Arcy
French, Dr. Carl B.
Fry, Harold
Fulton, A. G.
Fyfe, G. T.

G.

Gaby, Dr. F. A.
Gair Company Canada Limited
Gale, Becher R.
Gale, Geo. C.
Gale, Geo. T.
Gallie, Dr. W. E.
Gang, Israel
Garard, Wm.
Gardiner, Frederick G.
Gardiner, Percy R.
Garner, G. C.
Garrett, A. H.
Garrett, R. A.
Gaskon, Henry G.
Geiger, Douglas G.
Gelber, Louis
General Steel Wares Ltd.
General Supply Co. of Canada Ltd.
George, Frank S. S.
Gibbons, O. T.
Gibson, J. G.
Gibson, William S.
Gilchrist, Prof. L.
Gill, E. C.
Gilley, J. R.
Gillies, Duncan B.
Gillies, Dr. J. Z.
Godfrey, Bert
Godfrey, Samuel
Golden, Miss Greta
Goldie, Dr. Wm.
Goldsmith Bros. Smelting & Refining Co. Ltd.
Gooderham, M. Ross
Goodings, Dr. A. C.
Gordon, W. E.
Gotfrid, Samuel.
Goulston, B.
Gow, Walter
Graham, Dr. Duncan
Graham, Gordon
Graham, Kingsley
Graham, Dr. Roscoe R.
Graham, Walter T.
Grainger, H. A.
Grand & Toy Ltd.
Grand, Ernest J.
Grand, James R.
Grand, Percy F.
Grange, E. R.
Grant, Miss Alice A.
Grant, J. A.

G—Continued.

Grant, Prof. J. C. B.
Grant-Suttie, Lt.-Col. G. L. P.
Grassick, Dr. Neil H.
Gray, James
Gray, Miss Mabel
Great Lakes Paper Co. Ltd.
Green, H. J.
Greene, E. A.
Greene, V. G.
Greer, R. H.
Greey, Dr. Philip H.
Greig, Ewart
Greig, Melville M.
Griffiths, Idris M.
Grimbly, Maurice
Grubbe, Talbot P.
Gullett, Dr. Donald W.
Gunn, Donald D.
Gunn, E.
Gurd, Dr. G. W.
Gurney, E. Holt
Guyatt, Dr. B. L.

H.

Hackbusch, Ralph A.
Hackett, W. B.
Haddow, Dr. W. R.
Hair, Dr. C. H.
Halford, C. J.
Hall, Gerald R.
Hall, Hugh B.
Hall, Irving C.
Halladay, Archibald H.
Hallman, Gordon L.
Hamilton, Chester B., Jr.
Hamilton, Grey
Hamilton, J. P.
Hamilton, Robert J.
Hamilton, Russell J.
Hamilton, Mrs. Russell J.
Hamlen, E. L.
Hamly, Dr. D. H.
Hammell, John E.
Hargraft, A. A.
Harkness, W. Leonard
Harpham, Horace
Harrington, Dr. Paul
Harris, Dr. Charles W.
Harris, Chester J.
Harris, Dr. R. I.
Harris, W. C.
Harrison, C. D.
Harrison, Dr. Frederick C.
Harshman, H. H.
Hart, R. W.
Harvey, C. J.
Harvey, W. R.
Hastie, Wm. J.
Hastings, M. B.
Haultain, Prof. H. E. T.
Hay, Frank.
Hayhoe, Ralph J.
Heddle, C. M.
Heintzman & Co. Ltd.
Heise, B. W.
Hemmerick, George
Henderson, Lyman A.
Henderson, Q. B.
Henry, Hon. George S.
Herity, J. C.
Herlick, Carl M.
Hermann, Max
Hermant, Percy
Hermant, Sydney M.
Herring, John
Hewson, Ewart G.
Hibbert, E.
Higginbottom, C. E.
Higgins, A. T.
Higginson, S.
Hill, T. P.
Hillman, H. P. L.
Hinde & Dauch Paper Co. of Canada Ltd.
Hodgens, W. S.
Hogarth, G. H.
Hogg, Hon. Mr. Justice F. D.
Hogg, Prof. Frank S.
Hogg, Dr. T. H.
Holden, John B.
Holden, Mrs. John B.
Holden, Dr. Otto
Holman, Dr. William L.
Holmes, George L.
Holness, A. B.
Honey, Dr. S. Lee
Hooker, Dr. H. L.
Hooper, P. McF.
Hooper, V. A.
Hope, H. B.
Hopkins, Oliver B.
Hopkins, P. E.
Horsey, J. William
Horsfall, Herbert H.
Horsfall, W. H. Douglas
Howell, P. L.
Huckvale, Robert
Huffman, Geo.
Hughes, Hon. F. J.
Hughes, V. G.
Humble, George T.
Hume, D. C. M.
Hunt, John
Hunter, Carl H.
Hunter, Harry B.
Hurst, Fred C.
Huston, John A.
Hutchinson, J. D. H.
Hyland, James

I.

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Imperial Optical Company
John Inglis Company Ltd.
Interlake Tissue Mills Co. Ltd.
International Business Machines Co. Ltd.
International Nickel Co. of Canada Ltd.
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Ireton, Prof. H. J. C.
Irwin, R. E.
Isserstedt, S. Gordon

J.

Jack, Robert J.
Jackman, H. R.
Jackson, Prof. H. S.
Jackson, Prof. Kenneth B.
James, Dr. A. B.
James, L. E.
James, O. S.
James, Thomas B.
James, T. Conway
James, Dr. W. F.
Jamieson, H. T.
Jamieson, J. K.
Jamieson, Dr. Ross A.
Jaquith, Dr. D. A.
Jaquith, Dr. Hubert C.
Jaquith, Dr. L. Everett
Jaquith, Mrs. L. Everett
Jarvis, C. W.
Jefferey, J. J.
Jefferey, R. T.
Jeffrey, Frank R.
Jenkins, Rev. W. P.
Jennings, W. A.
Jephcott, Dr. C. M.
Johnson, Arthur Kemp
Johnson, C. W.
Johnston, Albert C.
Johnston, E. H.
Johnston, Iredell K.
Johnston, John

J—Continued.

Johnston, J. G.
Johnston, Dr. R. A. A.
Johnston, R. W. S.
Johnston, W. D.
Johnston, Mrs. W. D.
Jolliffe, W. H.
Jones, Carl M.
Jones, Dr. D. C.
Jones, G. R.
Jones, Miss Margaret
Jones, Robert W.
Jones, S. C.
Jowsey, R. J.
Joy, Col. D. G.
Joy, E. Grahame
Jull, Mrs. J. W.

K.

Kelley, W. A. G.
Kellow, R. S.
Kelly, Arthur
Kelly, Wm. J.
Kennedy, Byron B.
Kennedy, Gordon N.
Kennedy, J. B.
Kennedy, John R.
Kenrick, Prof. Frank B.
Kent, H. F. E.
Kerr, L. W.
Kert, Lawrence
Kidd, Kenneth E.
Kidd, John J.
Kilbourn, K. M.
Kilgour, R. C.
Kilpatrick, J. A.
King, Frederick C.
Kinnear, C. R.
Kinnear, Thos. H.
Kinsman, J. V.
Kipp, H. W.
Kishbaugh, W.
Knight, H. Watson
Knight, Norman
Knowlton, W. L.
Kopplin, G. A.
Kortright, F. H.
S. S. Kresge Co. Ltd.
Kristensen, O. E.
Kyle, John C.

L.

LaBine, Gilbert A.
LaChapelle, Robert
Laidlaw, Miss Ann
Laidlaw, John B.
Laidlaw, Miss Margaret C.
Lake Simcoe Ice & Fuel Ltd.
Laker, Benjamin
Lalor, John M.
Lamb, Col. H. J.
Landell, D. A.
Landow, W. P.
Lane, Major G. R.
Lang, Daniel W.
Lang Brothers Specialty Company
Langford, George B.
Langford, J. A.
Langmuir, F. L.
Langmuir, Col. J. W.
Larkin, G. R.
Laschinger, Jas. E.
Lash, John F.
Latimer Limited
Latimer, Harry B.
Latimer, William H.
Laughlin, W. H. M.
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Lawson, Hugh H.
Leach, T. L.
Leacock, Geo. D. Y.
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Leitch, Kelvin D.
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Leyerle, Dan B.
Lim Yuen, Andrew
Lindsley, Thayer
Linell, Dr. Eric A.
Little, Rev. W. J.
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Livingstone, H. E.
Lloyd, T. E.
Loblaw Groceterias Co. Ltd.
Lofft, H. W.
Logan, S. H.
Long, Edward S.
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Loosemore, H. H.
Lorenzen, I.
Lorriman, Prof. Fred R.
Lotimer, J. S.
Loudon, Dr. Julian D.
Loudon, Prof. T. R.
Lougheed, Dr. G. W.
Lougheed, H. James
Lowery, Dr. R. P.
Lucas, Prof. G. H. W.
Lumbers, G. C.
Lunau, Rev. Austin E.
Lundberg, H.
Lundy, Stanley
Luscombe, J.
Luxenberg, Benjamin
Lyons, G. Jarvis.

M.

MacAlpine, Col. C. D. H.
MacBeth, John C. M.
MacBrien, W. A. H.
MacDiarmid, Geo.
Macdonald, C. E.
Macdonald, D. Claude
MacDonald, K. D.
MacDonald, John T.
Macdonald, Norman
MacDonnell, Roy H.
MacDougall, F. A.
Macfadyen, A.
MacFadyen, W. T. A.
MacFarlane, J. C.
MacInnes, C. S.
Macintyre, Grant
MacKelcan, F. R.
Mackenzie, Prof. M. A.
Mackenzie, Morley E.
Mackinnon, J. B.
MacKinnon, Ronald S.
Mackintosh, James
MacLachlan, D. C.
Maclachlan, K. S.
Maclachlan, Wills
Maclaurin, Dr. Norman T.
MacLean, Prof. A.
Maclennan, R. J.
MacMillan, George A.
MacMillan, Wm.
Macmillan Co. of Canada Ltd.
MacMurchy, N. A.
Macphee, Norman
Macpherson, G. L.
Macrae, Arthur S.
MacRory, John
Magner, Dr. William
Maher, Jas. P.
Malcolm, W. G.
Malcolmson, C. D.
Mallett, G. Stuart

Mallison, Fred
Malone, W. B.
Marcus, S. G.
Markowitz, Dr. Jacob
Marks, W.
Marsh, Wm. H.
Marshall, F. W.
Marshall, Dr. H. Borden
Marshall, Col. K. R.
Martin, Dr. Alvin
Martin, G. S.
Martin, S.
Mason, Dr. A. D. A.
Mason, A. J.
Mason, T. H.
Mason, V. F.
Massey, Denton
Massey, Rt. Hon. Vincent
Mathers, A. S.
Matthews, Hon. Albert
Matthews, Dr. A. W.
Matthews, C. A. G.
Matthews, Douglas C.
Matthews, Hon. R. C.
Matthews, R. G.
Matthews, Thomas A.
Matthews, T. Frank
Matthews, Mrs. W. L.
Maunsell, J. Q.
Maurice, A.
McAree, T. C.
McCaffrey, Ernest R.
McCarthy, D. L.
McCarthy, Hon. Leighton
McClain, John F.
McClelland, D. McK.
McClelland, Dr. James C.
McCloskey, H. C.
McCordick, A. S.
McCrea, Hon. Charles
McCrimmon, Bruce V.
McDonagh, Very Rev. J. A.
McDonald, P. E.
McEvenue, S. C.
McEwen, Edward
McFarland, Hon. Mr. Justice G. F.
McGaw, T. D.
McGee, T.
McGee, Mrs. T.
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Royal Canadian Institute

SERIES IIIA SESSION 1946-47 VOL. XII

This publication is issued with the object of conveying a general idea of what the Royal Canadian Institute endeavours to do, along with a brief outline of what it has done in the past. The publication contains abstracts of the popular scientific lectures given each Saturday Evening in Convocation Hall, University of Toronto, during the 98th Session, 1946-1947.

135 ST. CLAIR AVENUE WEST
TORONTO 5, CANADA

CONTENTS

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of the

Royal Canadian Institute

1947 -1948

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(Royal Charter granted November 4th, 1851).	
WILLIAM (AFTERWARDS SIR WILLIAM) E. LOGAN, C.E., F.R.S., ETC.	1850–51, 1851–52
CAPTAIN (AFTERWARDS GENERAL SIR J. HENRY) LEFROY, R.A., F.R.S., ETC.	1852–53
HON. CHIEF JUSTICE (AFTERWARDS SIR J. BEVERLEY) ROBINSON	1853–54, 1854–55
G. W. (AFTERWARDS HON. G. W.) ALLAN	1855–56
HON. CHIEF JUSTICE DRAPER, C.B.	1856–57, 1857–58
HON. G. W. ALLAN	1858–59
PROF. (AFTERWARDS SIR) DANIEL WILSON, LL.D., F.R.S.E.	1859–60, 1860–61
HON. J. H. (AFTERWARDS CHIEF JUSTICE SIR JOHN) HAGARTY	1861–62
REV. J. McCAUL, LL.D.	1862–63, 1863–64
HON. (AFTERWARDS SIR) OLIVER MOWAT	1864–65, 1865–66
PROF. HENRY CROFT, D.C.L.	1866–67, 1867–68
REV. PROF. WILLIAM HINCKS, F.L.S.	1868–69, 1869–70
REV. HENRY SCADDING, D.D.	1870-71, 1871-72, 1872-73, 1873-74, 1874–75, 1875–76
PROF. JAMES LOUDON, M.A., F.R.S.C.	1876–77, 1877–78
PROF. (AFTERWARDS SIR) DANIEL WILSON, LL.D., F.R.S.E.	1878-79, 1879–80, 1880–81
JOHN LANGTON, M.A.	1881–82
J. M. BUCHAN, M.A.	1882–83, 1883–84
PROF. W. H. ELLIS, M.A., M.B.	1884–85, 1885–86
W. H. VAN DER SMISSEN, M.A.	1886–87, 1887–88
CHARLES CARPMAEL, M.A., F.R.S.C.	1888-89, 1889–90, 1890–91
ARTHUR HARVEY, F.R.S.C.	1891–92, 1892–93
R. RAMSAY WRIGHT, M.A., LL.D., F.R.S.C.	1893–94, 1894–95
A. B. MACALLUM, M.A., PH.D., LL.D., F.R.S.	1895-96, 1896–97, 1897–98
B. E. WALKER, D.C.L., F.G.S. (AFTERWARDS SIR EDMUND)	1898–99, 1899–1900
JAMES BAIN, D.C.L.	1900–01, 1901–02
A. P. COLEMAN, PH.D., F.R.S.	1902–03, 1903–04
GEORGE KENNEDY, M.A., LL.D., K.C.	1904–05, 1905–06
R. F. STUPART (AFTERWARDS SIR FREDERIC)	1906–07, 1907–08
J. J. MACKENZIE, B.A., M.D.	1908–09, 1909–10
J. B. TYRRELL, M.A., F.R.S.C.	1910-11, 1911–12, 1912–13
F. ARNOLDI, K.C.	1913-14, 1914–15, 1915–16
J. C. McLENNAN (AFTERWARDS SIR JOHN), PH.D., F.R.S.	1916–17
J. MURRAY CLARK, LL.B., K.C.	1917–18, 1918–19
PROF. J. C. FIELDS, PH.D., F.R.S.	1919-20, 1920-21, 1921-22, 1922-23, 1923–24, 1924–25
PROF. J. J. R. MACLEOD, D.Sc., LL.D., F.R.S.	1925–26
ARTHUR HEWITT	1926–27, 1927–28
PROF. W. A. PARKS, PH.D., F.R.S.	1928–29
PROF. R. B. THOMSON, B.A., F.R.S.C.	1929–30
T. A. RUSSELL, B.A., LL.D.	1930–31
E. F. BURTON, O.B.E., B.A.TOR., CAMB., PH.D., F.R.S.C.	1931–32
JOHN PATTERSON, M.A., LL.D., F.R.S.C.	1932–33
SIR ROBERT A. FALCONER, K.C.M.G., D.LITT., LL.D., D.C.L.OX., F.R.S.C.	1933–34, 1934–35
J. ELLIS THOMSON, B.A.Sc., PH.D., F.R.S.C.	1935-36, 1936–37, 1937–38
ARTHUR R. CLUTE, K.C.	1938–39
PROF. J. R. DYMOND, O.B.E., M.A., F.R.S.C.	1939–40
WILLS MACLACHLAN, B.A.Sc.	1940–41
PROF. L. JOSLYN ROGERS, B.A.Sc., M.A.	1941–42
PROF. T. F. McILWRAITH, M.A. (CANTAB.), F.R.S.C.	1942–43
OTTO HOLDEN, B.A.Sc., C.E., D.ENG.	1943–44
PROF. E. S. MOORE, M.A., PH.D., F.R.S.C.	1944–45
T. W. EADIE, B.Sc.	1945–46
PROF. T. R. LOUDON, B.A.Sc.	1946
C. F. PUBLOW, B.A.Sc.	1946–47
HARVEY AGNEW, M.D., F.A.C.P., F.A.C.H.A.	1947–48

THEN AND NOW

THE Royal Canadian Institute has as its object the promotion of science and the results of scientific research. It attempts to inform and educate the public on important matters of general interest; to stimulate research and to act as liaison between the scientist and the public.

The Institute was established in 1849 in Toronto, at that time the capital of Upper Canada, by a small group of surveyors, architects, and civil engineers. When incorporated in the Province of Upper Canada in 1851 it was definitely to serve Upper Canada which, in the enlarged Dominion of Canada, came to be the Province of Ontario. If it had been established after Confederation it is likely that it would have been called the Ontario Institute.

The original members of the Institute were William E. (later Sir William) Logan, John O. Brown, Frederick F. Passmore, Kivas Tully, William Thomas Ridout, and Sandford (later Sir Sandford) Fleming. Of these, Sir Sandford Fleming, the originator and founder of the Institute, was the last survivor.

A story of interest from the pen of Sir Sandford Fleming, a great Canadian and a pioneer in engineering, describes the enthusiasm of the early founders:— On February 8th, 1850, a meeting was held to discuss plans for the newly formed organization. Only two members attended, F. F. Passmore and Sandford Fleming. The prospects of the young Institute were not brilliant, but the two determined to act with energy, if not with entire regularity. After much silence and long waiting in vain for other members to appear, the one addressed the other in these words: "This looks bad—we must, however, proceed, as the saying is, to make a spoon or spoil the horn. Let one of us take the chair and the other act as secretary," and so agreed, dispensing in the emergency with a quorum, they passed a series of resolutions with complete unanimity. No amendments were offered and time was not spent in long discussions; those present deemed it a dispensable formality to have "movers" and "seconders" to the motions submitted. As appears by the minute book the meeting simply "resolved" this or that. One resolution adopted and formally placed on record, reads: "Resolved, That the members of the Canadian Institute do after this date meet once a week, on each Saturday at 7 o'clock p.m., in the Hall of the Mechanics' Institute. The first meeting to take place on Saturday next, February 16th, 1850." No fault was ever found with the action taken on that occasion and meetings have been held without interruption since that date.

At the earlier meetings, papers on scientific problems of the day were read and discussed and laboratory work was carried on by the various sections which were established under the administration of

the Institute. The most important of these were the Biological Section, the Geological and Mining Section, and the Historical Section.

The early publications of the Institute, beginning with the year 1851, were also of great value because they were the only ones of their kind in the scientific field in Canada. The first of these publications, "The Canadian Journal: a Repertory of Industry, Science, and Art," was edited by Henry Youle Hind, who conducted explorations in western Canada, and there followed the well-known series on "Toronto of Old" by the Rev. Henry Scadding, D.D., who was President of the Institute from 1870 to 1876.

When the Canadian Institute moved from its building at the corner of Richmond and Berti Streets in Toronto in 1905 to become more closely associated with the University of Toronto it began to establish a more direct communication with the public. On April 2nd, 1914, His Majesty the King granted permission to the title "Royal" and it became the Royal Canadian Institute.

In aiding the public to appreciate and understand the value of research, the Institute has had an important influence in increasing research facilities in Canada. During the First World War the Royal Canadian Institute established a Bureau of Scientific and Industrial Research to promote closer co-operation between science and industry in the prosecution of the war. As a result of publicity given to the value of enlisting scientific aid in the war effort, the federal government appointed an Honorary Advisory Council on Scientific and Industrial Research which later developed into the National Research Council with extensive laboratories in Ottawa. Public realization of the value of science after the war led to the establishment of the Ontario Research Foundation and to increased grants for research in the universities.

During the last few years the Institute has been playing an important part in the promotion of the conservation of our natural resources. It co-operated in the formation of the Guelph Conference organized to study these problems and make representations to the Provincial Government.

Scientific research was never more necessary than it is to-day in enabling us to develop the resources of our country so that they will yield the greatest possible return. The public should be enlightened on the applications of science to modern problems.

The contributions of science to our material welfare are, however, only a part of its significance to mankind. Probably even more important is its general educational value. It opens to us a broader vision of the world, developing more accurate habits of thought, and thus leading to a greater enrichment and enjoyment of life. For these reasons the educational work of the Royal Canadian Institute is one of the most valuable of its activities.

Some of the Outstanding Accomplishments of the Royal Canadian Institute

1. Co-operation in promoting the meetings in Toronto of the following scientific societies.

(a) The American Association for the Advancement of Science, 1889 and 1921.

(b) The British Association for the Advancement of Science, 1897 and 1924.

(c) The International Geological Congress, 1913.

(d) The International Mathematical Congress, 1924.

2. Standard Time.

In 1878 Sir Sandford Fleming brought forward the plan of adopting for the whole earth twenty-four standard meridians, fifteen degrees apart in longitude. He published many papers on this subject, and with the co-operation of the Institute, the zone system of time-reckoning was adopted in most of the countries of the world.

3. The Museum.

The Ontario Archæological Museum was begun under the auspices of the Institute, and continued under its management for six years before being transferred to the Ontario Government and the University of Toronto.

4. The Ontario Good Roads Association.

The Ontario Good Roads Association was organized as the outcome of a meeting called by the Canadian Institute in 1894.

5. Publications.

The publications of the Institute have appeared as follows:—

(1) "The Canadian Journal: a Repertory of Industry, Science, and Art," and a Record of the Proceedings of the Canadian Institute. 3 vols., 4to. Begun August, 1852, ended December, 1855.

(2) "The Canadian Journal of Science, Literature, and History." 15 vols., 8vo. Begun January, 1856, ended January, 1878.

(3) "Proceedings of the Canadian Institute." 7 vols. Begun 1879, ended April, 1890.

(4) The Archælogical Reports of the Canadian Institute were published as part of the Appendix to the Report of the Minister of Education for the Province of Ontario, 1886-1894.

(5) Minor Series. "Proceedings of the Canadian Institute." From 1897 to 1904, two volumes of this series, containing short papers, were published.

(6) "Transactions of the Royal Canadian Institute." Begun October, 1890, and up to October, 1946, Part I of the twenty sixth volume has been published. This publication contains scientific papers on technical subjects relating to all branches of science. These papers are submitted by those doing research work. The publication is sent to learned societies throughout the world, and these societies send their own publications in exchange. Any Ordinary member of the Royal Canadian Institute may receive a copy of this publication upon request.

(7) "Proceedings of the Royal Canadian Institute." Series IIIA. Abstracts of the lectures given during the year. Begun 1936 and to date twelve volumes have been published.

(8) General Index to Publications, 1852-1912. Compiled and edited by Dr. John Patterson. Dr. J. B. Tyrrell, President of the Institute, 1910-1913, undertook to finance the compilation of the index, and made it possible for the Council to proceed with the work.

6. The Library.

As a result of the exchange of publications with learned societies for the past ninety-seven years, the Institute has built up a most important scientific library containing thousands of volumes which are indispensable to scientific workers and are not otherwise available in this part of Canada. This library is housed in a section of the library of the University of Toronto, and may be used by the staff and students of the University as well as by members of the Institute.

7. The National Research Council and the Ontario Research Foundation.

It was in large part due to the vigorous campaign of the Institute on behalf of a wider application of science to industry in Canada, that the Honorary Advisory Council for Scientific and Industrial Research, the forerunner of the National Research Council, was appointed by the Dominion Government, and that the Ontario Research Foundation was instituted through the co-operation of the Ontario Provincial Government and manufacturers.

8. University Grant.

The Institute also strongly supported the successful application to the Provincial Legislature for an annual grant for research in the University of Toronto.

Report of the President

1946-1947

As presented to the 98th Annual Meeting, on Friday, April 11th, 1947, held in The Art Gallery of Toronto.

At an Annual Meeting it is customary for the President to report on the year's activities. I should like to say that we have had a very successful year—and then sit down—but I rather feel that it is my duty to thank you, on behalf of my colleagues, for the support you have given to a work which we deem to be extremely worth-while. You have been generous in your understanding and friendliness and it has indeed been an honour to be your President.

Although our activities are a small part of the varied influences which touch upon our way of life, nevertheless, those who believe in democracy must believe in the value of organizations such as the Royal Canadian Institute. For most of us, our education is actually built on what we see and hear as well as what we read. It is our good fortune to hear authorities on many branches of science and to have their intensive work in research brought to us so that the average person is able to understand and know something of modern developments in science. The fact that our Saturday Evening Lectures are well attended — the total of those present in the past season being over 22,000 people, an average of 1,100 per meeting—creates a sense of encouragement that is felt not only by your Council, but also by our guest speakers, who often tell us that never have they addressed such an appreciative and intelligent audience as that which comprises our Saturday Evening meetings in Convocation Hall.

We held twenty meetings this season, three of them jointly with sister organizations. Seven of our guest speakers were local scientists, four came from other parts of Canada, and nine from the United States.

We had the privilege this session of having His Excellency the Governor-General officially attend and address the meeting on November 23rd, 1946, and we are very grateful to Professor Bain for acting as Chairman of the Committee in charge of the special arrangements for the visit. Professor Bain and his Committee were responsible for the reception of His Excellency, the special guests, and the general procedure at the meeting. Every detail received consideration and was carried out successfully. The full text of His Excellency's address on "Timing as a Factor in War" will appear in the "Proceedings"—our publication containing abstracts of the lectures given during the session. This publication goes to press usually in September of each year.

Our publications are a very important activity. The "Proceedings," a book which records our lectures, is meant for general reading, while our "Transactions," a publication containing papers on original scientific research, serve as a medium of permanent record to the research worker for the recording of his findings. Both these publications serve as exchange material and are sent to learned societies throughout the world. As you may well imagine, the editing of these publications is an arduous task that could only be accomplished by one who is fundamentally a true scientist. Our Honorary Editor, Dr. E. Horne Craigie, has generously given of his time and effort to this work and we are most grateful to him.

The reputation which the Institute enjoys depends to a large extent on this thoroughly sound basis of publishing scientific papers, but to gain the support of the public in order to do this, we have to rely on publicity and our public relations activities. There are two Committees which have meant a great deal to the life of the Institute this session. One is the Publicity Committee under the Chairmanship of Mrs. O. D. Vaughan—who, by the way, has also been responsible for the pleasant arrangements for this evening. Mrs. Vaughan and her Committee have kept our interests before the public by means of press and radio publicity. Our thanks are also due to Professor T. F. McIlwraith for arranging for someone each week to be responsible for the press conference.

The other Committee, our Membership Committee, under the Chairmanship of Mr. Norman Knight, has done its share in extending our influence. This year 152 new members were elected to membership in the Royal Canadian Institute. Of these, 89 came to us unsolicited, recommended by individual members. It seems to me that an organization such as ours which is increasing its membership without a so-called membership campaign, without solicitation, is worthy of public confidence. We hope we may continue to have the goodwill and support of our 1,941 members, whose number we expect to increase to at least 2,000 next year.

But all has not been smooth sailing. We have had many problems not unlike those which face the world to-day. We have gone through a period of adjustment and unrest, trying to find out where we might fit in, and what course our future policy should take. You will recall how dramatically Air Vice-Marshal Stedman, our guest speaker who told us of the atom bomb tests at Bikini, brought us to realize that the world is at the "crossroads." This is the time when every nation, every community, indeed every individual should "take stock" to determine where we are going and how we are going to get there.

Your Institute, with an enviable record through ninety-eight years, has arrived at a time in its history when it must again recognize changing conditions. What am I driving at? Just this!

In a brief period of twelve months—(1) we have had to uproot ourselves from a building we had occupied as headquarters for forty years—one located on the property of the University of Toronto, with which we have been closely associated; (2) we have had to find new quarters for office space and storage accommodation for a portion of our library; and (3) we have had to meet a crisis in our library problem which has been troubling us for many years—that of insufficient accommodation.

You may recall that when we first learned that we would have to vacate our building at 198 College Street we purchased the property at the southwest corner of College and Henry Streets. This has proved to be a very sound investment, but owing to the present housing regulations we have not been able to occupy it. We were fortunate, however, in obtaining office space sufficient for our present needs at the south-east corner of Avenue Road and St. Clair Avenue. Nevertheless, it is a great handicap to be so far from the University, with which we have had such close relations. To many ladies present this evening, it should not be necessary for me to emphasize the unpleasant experience of "moving." Most of us know that such conditions are most trying and difficult.

As a further example of the troubled times which the Institute has experienced during the past year, the Library offers a complete picture in itself. Five months were devoted to the task of moving our library at a cost of approximately $1,000. This was a necessary expense, but one which resulted in no actual improvement in the library. Books had to be packed and crated and a good many had to be placed in dead storage.

Considering the limited amount of assistance and finances at our disposal, it is interesting to find that we were able to accomplish so much as we did during the past year in renewing our exchanges broken by the war; arranging new exchanges; providing an alphabetical list of our holdings; binding accessions received; and still fulfilling requests for interlibrary loans and individual loans.

The problem as outlined in the President's report of last year, as to whether the Institute should maintain a separate independent library, received a thorough study by a special Committee set up for this purpose. After careful consideration of this Committee's report by Council, it has been decided to present to this meeting a resolution of great importance, authorizing Council to take action with regard to the future existence of the library. It was felt that any decision affecting so important a part of the Institute should be brought to the attention of our members. The fact that the Council wishes to keep the members informed of their recommendation should clearly illustrate that your Council is deeply conscious of the valuable contribution our library has made, and it is with this thought in mind that it is believed we can increase our contribution to the advancement of science by making our books available in other libraries.

I know something of the time and effort that has gone into the study of our library problem by our Honorary Librarian and his Committee so ably supported by the work of Mrs. Warrener, our Librarian. I assure you that it is not without a good deal of reluctance that we arrived at the decision to give up the idea of an independent and separate library.

Beyond these adjustments and trials, your Institute has still been progressive enough to carry through a new venture successfully. In co-operation with the Toronto Field Naturalists' Club the Royal Canadian Institute brought to Toronto, and incidentally to Canada for the first time, five of the leading lecturers in natural history in the United States. These lectures were given in Eaton Auditorium by members of the staff of the National Audubon Society in the United States. They have come to be known throughout the United States as the Audubon Screen Tours, and with many more of these lectures available we may look forward to another series next season. The Screen Tours have become established in London, Ontario, and steps have been taken to include Hamilton, Ottawa, and Montreal in next season's Tours.

The purpose of the Screen Tours is to further the cause of conservation education. Your Institute has pioneered in this work for many years and we have been glad of the opportunity to join with the Audubon Society to foster this movement in Canada. As a definite gesture in support of local conservation organizations, we gladly responded to an appeal to assist in the publication of a report on certain studies carried out to develop the Humber Valley area. Perhaps our efforts in the future should be directed with more energy along the road that will lead to a wiser use of our natural resources.

From this brief reference to our country's natural resources, I come now to a discussion of the Institute's financial resources. It must not be expected that we could hope for a favourable balance after an unusual year of extraordinary expense when the cost of moving became such a heavy burden on our finances. Our budget is a modest one but I am sure it receives as much care and thought as that of any business today. Your Finance Committee, under the able chairmanship of Mr. John S. Dickson, is to be congratulated on having managed so well to keep our expenses at a minimum. I am not going to burden you with an itemized account of the financial statement which has been audited by Messrs H. Frank Vigeon and H. C. Brown. I am sure you will be interested to know, however, that our receipts amounted to $10,757.76 and our expenditures to $12,020.62, making a deficit balance of $1,262.86. A copy of the audited statement will be sent to any member on request. I wish to acknowledge with sincere thanks, the valuable service which Mr. Vigeon, and his father before him, have contributed to the Institute by auditing our books without fee, over many years. We are grateful also to Mr. H. C. Brown who, for the

past two years, has donated his services as the second auditor of the books, as required by our Constitution.

The monies received from the sale of our former building to the University of Toronto ($12,000), were invested in Dominion of Canada Bonds. Some of the Dominion of Canada Bonds already held in our reserve accounts were sold at a premium and more recent issues bought. I can assure you that the finances are in good hands and that everything is being done to administer the funds wisely and well.

Were it not for the generosity of our many friends and supporters, the Institute would not be in so strong a financial position as it is to-day. This is a wealthy organization if due value is placed on the amount of time and effort devoted to our activities. We have what is called an Entertainment Committee for want of a better word, and this Committee, under the capable leadership of Dr. Frank S. Hogg, has done much to create a warm reception to our guest speakers. Members of the Council and many members of the Institute have shared in entertaining our speakers. The many courtesies extended to them have been greatly appreciated, and have done much to enhance the reputation of the Institute in other centres on this continent—a reputation of generosity, friendliness, and goodwill.

On your behalf, I wish also to acknowledge our indebtedness to Dr. T. A. Davies who has so greatly added to our enjoyment at our meetings throughout the year by his organ recitals. Dr. Davies has devoted much more time than we actually observe, for each organ recital represents much previous work and thought. We thank you most warmly, Dr. Davies, and we want you to know how much enjoyment you have given us.

The Annual Meeting is the occasion when we elect a new governing body. It is also the occasion when we express our appreciation to those retiring from the Council who have served the Institute well. To me, the strength of an executive is not only the personnel of that body, but it is also in the support that is given by those who serve outside that executive. When, according to our regulations, we must necessarily lose the immediate services of those who have contributed much towards the furtherance of our work, we do so with the hope that they may continue their interest and usefulness for the Institute.

On your behalf I acknowledge the services rendered by Dr. H. A. Cates, Mr. George C. Gale, Dr. Sigmund Samuel, and Dr. Otto Holden who retire from Council this year.

As I mentioned earlier, the Royal Canadian Institute is fortunate in its wealth of good friends, but if I were asked the reason for this, I would

not hesitate in replying—George Gale. Throughout fifteen years of continuous service, Mr. Gale has been particularly active on the Membership Committee, frequently as its Chairman, but always as an ardent, enthusiastic worker. And he, perhaps more than any living person, is responsible for our wide membership and the financial support given by so many business firms in the community. When Mr. Gale first became a member of the Council in 1932, the Institute was known to few people. Through his example we have come to realize how much can be done by one man.

Along with Mr. Gale, we must lose another enthusiastic Councillor in the person of Dr. Sigmund Samuel, who has served us for seventeen years. Our Council meetings will not be the same without these two faithful supporters, but we hope that their interest in the Institute will continue and we look forward to seeing them regularly on Saturday evenings in Convocation Hall.

It is also with a real sense of loss that we accept Dr. Otto Holden's retirement from Council. He has given valued leadership and has been a steadying influence in all our deliberations. We trust that Dr. Holden will continue to give us the benefit of his wise counsel and sound judgment.

It is customary for the President at an Annual Meeting to express the thanks and appreciation of the Council for the continued co-operation of all those who have helped to make this such a successful year. This is a very proper custom. However, if I may be permitted to single out two people who have made my own responsibilities and those of my colleagues much less difficult, it would be our Executive Secretary and our Honorary Librarian. To Mrs. Florence C. Rawlings I extend our warmest appreciation for the faithful, efficient and courteous services she and the staff have rendered to the Institute. At times they have worked under trying conditions caused by lack of proper accommodation, but Mrs. Rawlings and her associates responded to the challenge and I should like to extend our sincere thanks to them for their meritorius efforts on your behalf. It is difficult to find adequate words to describe the extent of the contribution of our Honorary Librarian, Mr. Bruce Murray, not only to that which was definitely assigned for his special direction, but also to many other phases of our work. By his quiet, unassuming, yet always persistently enthusiastic helpfulness, he is ever burning the midnight oil in the interest of the Institute, and we are greatly indebted to him.

As we come to the end of our 98th session I wonder—What of the future? In two years we will be a hundred years old. The founders of this organization builded greater than they knew. Are we going to accept their challenge to carry through their ideals? Some time ago we laid our plans for a Centennial Celebration. The appointed Standing Committee, under the Chairmanship of Mr. Wills Maclachlan, has recom-

mended, and Council has approved, the preparation of a book giving a brief history of the Institute and its contribution to Canadian life. The book will also present a summary of the advances in various branches of science over the past hundred years with particular reference to their effect on Canada. It will be written for the enjoyment and profit of the general reader. You are assured that other plans will develop as the time draws nearer.

Whatever our tasks in the future may be, we must realize that it will be through the unselfish co-operation of everyone that we shall gain the answers to the biggest problems mankind has ever faced. Intellect, experience, ability, foresight, the observations of wise men, and the theories of profound scientists—these must all play a part in our struggle for a peaceful civilization. But far surpassing these in importance is unselfishness. This is the spirit which permeates the Institute's work. In view of this report, I think it is fair to say that the present Council has a certain pride of accomplishment—yes, it is proud of a job well done but not satisfied—for the goal appears to have been but dimly visualized, and the road ahead is still fraught with difficulties. However, the challenge is an inspiration. As I hand over the responsibilities of this office I congratulate my successor in having the opportunity of serving with such an unselfish body of people and with such a splendid organization as the Royal Canadian Institute.

C. F. PUBLOW, President.

The Saturday Evening Lectures

One of the objects of the Royal Canadian Institute is to further a popular interest in research. Since the results of research are so far-reaching in their effect upon the life of every member of the community, it is necessary to create an intelligent public who will be able to follow the work and achievements of those who are engaged in it.

What has been done in the past is illustrated by such important accomplishments as the invention of the telephone and the radio, the discovery of radium, the improvement of the telescope, also by the immense access of knowledge as to the structure of matter, whether in the atom or the universe, the manifold phases of life on the earth, and the exploration of the world.

The lectures of the Institute are the medium whereby such work is explained to the public. On Saturday evenings during the season, popular lectures of a scientific nature are given by men outstanding in their own field. The purpose is to interpret scientific research for the public.

"Some Glimpses of Nature's Fireworks"

C. F. PUBLOW, B.A.Sc.

Assistant Engineer, Hydro-Electric Power Commission of Ontario.

PRESIDENTIAL ADDRESS.

November 2nd, 1946.

During this past war, man seems to have reached an all-time high in the art of destroying both himself and the works of his hands. We have all heard of how England's vital public services were menaced over and over again by enemy bombings—among them the power system. Only tremendous organization, ingenuity, and hard work kept the line open. In this country we are fortunate not to have had to face the terrible destruction of war. Sometimes, however, nature can turn on a blitz of her own that can make human warfare seem amateur. Bringing into play all her old-fashioned weapons—lightning, sleet, hail, and hurricane—she can do a very efficient job of serious and widespread destruction. Of these, lightning is both highly dramatic and at times quite destructive when it comes to electric power systems.

In 1943, your president, Dr. Otto Holden, discussed with you "Canada's Water Power—Its Development and Importance." In his address he stated that more than 98 per cent of the electrical energy used in the Dominion to-day is derived from the power of falling water. You may be unaware that that same power, after it has been generated in various parts of this province, often has to travel hundreds of miles before it reaches the populated centres of industry where it is to be used. To be exact, 55 generating stations carry Hydro power over 9,500 circuit miles of transmission lines to the sub-stations of each municipality. Here the power is stepped down and then sent out again over untotalled thousands of miles of power lines into every corner of this large province. My purpose at present is to discuss with you how these precious arteries of power, on which our daily living is now so dependent, are safeguarded against the aforementioned trouble-makers of Nature, in particular, lightning.

To return to electricity, although we use it every day for many purposes we still know very little about it. It remains a mysterious something that, fortunately, we know how to produce, use, and control. Modern theories enable us more and more to extend these uses and controls. We have come to take it so much for granted that if there is ever a break in the service we resent it and feel there is little excuse for it.

Actually, when we consider the isolated location of the water-fall sites and those same thousands of miles of power lines, the wonder is that it ever gets to us at all. To look at the problem a little more closely, say you are a resident in Toronto, and assume that the electrical energy you are using in your home comes from the power in the falling water of the Ottawa River at Chats Falls generating station, upstream from the city of Ottawa and some 200 miles away. At this point electrical energy is generated at a pressure of 13,000 volts, transformed to 220,000 volts, and then transmitted to Toronto over one of four power lines ("ribbons" of aluminum supported on steel towers about five to a mile) with a portion of it running through almost virgin wilderness. At Toronto it is transformed first to 110,000 volts, and then to 13,000 volts, and distributed through cable to load centres in your own district. From here it is again sent by cable to local centres where it is stepped down to a distribution voltage of 4,000, and it will then arrive on your street by cable or overhead lines where it is again transformed down to your house service voltage (110 volts) and delivered right to your door by still more wire and cable. You must agree that this is a long and devious path and if anything goes wrong on any part of that long route you may be immediately without power, which is awkward enough if you are in the middle of cooking dinner or doing the washing!

Intricate power-system interconnections and modern high-speed relaying can effect localization of most troubles, thus usually preventing major interruptions.

Power failures are of two kinds, momentary or temporary, and permanent or major, the latter demanding the restoration of essential parts before power delivery can be resumed. These failures may be due to deliberate, accidental, or natural causes, and a frequent patrol must be on the alert all the time to locate and repair. Often this has to be carried out during very inclement weather and at night.

In the deliberate and accidental failures we are not so much interested right here. They would include sabotage, the wilful destruction that sometimes boys go in for when they use insulators as targets for rifle practice or stone throwing, and accidents like a child's kite getting entangled in the line, or a car going out of control and breaking a transmission pole.

Despite the best of men's efforts to minimize the effect of natural disturbances and despite all reasonable precautions in construction, there can still be power failures as long as man is unable to prevent Nature from performing the unpredictable. The havoc wrought by a cyclonic wind indicates that none of the precautions taken by power companies in modern times can prevent a power failure. We have a

good recent example of this in the Windsor area where the local district bore the brunt of the storm and also the power interruption. Another damaging storm happened some years ago north of Belleville and just east of Bannockburn in a relatively inaccessible location when three of the four 220,000 volt transmission lines were damaged beyond immediate repair, seriously curtailing the delivery of electricity to the Toronto area and points west for an extended time. This particular storm seemed to come out of a blue sky, just at office closing time in October, 1941.

When such interruptions occur and when, as in Windsor, other public services are disrupted, restoration of service is often badly delayed. In such instances the area of the damage must first be located, often a difficult piece of work, the extent of the damage must be appraised, and then the needed material and skilled men must be sent together with the required living accommodation to effect speedy work. For, like an army, these men must travel on their stomachs! It is no mean task, but in these cases team-work and realization of each individual's task soon accomplished temporary repairs and, shortly after, permanent ones were made.

Magnetic Storms

It was only comparatively recently that magnetic storms were recognized as a source of trouble for power systems. Communication companies have been coping with this problem for about half a century and as their systems grew larger and the service more exacting, greater efforts have been made to overcome the effects of such storms. When we all started using radios, we became directly aware of these disturbances in the form of static.

Severe magnetic storms have long been evident in unusual displays of "northern lights" which many of us were told in our younger days were caused by the sun shining on polar ice fields. I recall one spectacular display on Hallowe'en about the turn of the century. It was so disturbing to the telegraph companies that they were reported to have operated for several days without batteries and had the greatest difficulty in getting any messages through. Trains on branch lines had to proceed on their way without orders. Until a very few years ago power engineers were unaware that such "storms" would affect their systems. In March, 1940, a number of unexplained interruptions occurred on several large systems over a widespread area — New England, New York, eastern Pennsylvania, southern and eastern parts of Minnesota, Ontario, and Quebec. When these were tabulated they were found to be coincidental and similar in character. This put power operators on the "alert," but it was not, as far as I am aware, until this year in February, in March, and again in September that they had definite results.

These three occurrences were all in Ontario and all on one system, their severity being indicated by disturbances on the power system, on telephones, and on radios. The trouble of last February caused four interruptions to apparatus and a considerable amount of work since it was thought some equipment failed and must be replaced. The interference in March caused six interruptions, and the latest one, in September, eight. Fortunately, none of these latest operations caused any curtailment of power service. We were fortunate to obtain graphic records of these extraneous influences.

Apparently these magnetic storms create differences in electrical potential between points on the earth's surface. Power and communication circuits connect such points with conductors which form a circuit parallel to the earth path, and so, unusual currents, superimposed on the power current of the system, flow in the conductors and station equipment at each point where connected to earth in an effort to equalize the potential difference and affect the normal functioning of the relay protective equipment. The current-flow reverses frequently and varies with the violence of the storm and its direction relative to the points grounded on the system.

Communication-company observers have been accumulating data on such occurrences and it has been definitely established that there are continuous changes due to this cause, but generally they are so small that they have no noticeable effect on their circuits even with "earth-return."

The search for the unknown is intriguing. Encouragement comes when results, however meagre, are obtained. These serve to whet the appetite and usually suggest new avenues of approach in gathering additional data. Since further disturbances are now anticipated in the near future, it will be interesting to await the outcome. The choice of effective precautionary measures on power systems to control these has yet to be made although certain effective means are known.

Harlan T. Stetson in "Terrestrial Magnetism," vol. 45, page 77, 1940, has this to say: "It was early recognized that auroral displays must be associated with ionization of the upper air at high altitudes, and various hypotheses have been advanced to account for increased ionization during periods of major solar activity. Whatever may be the differences of opinion in regard to the mechanism connecting sunspots with auroral displays, there is some evidence that auroral phenomena are intimately associated with sunspots themselves, rather than with a general state of radiation emission accompanying the solar cycle."

To date, these phenomena have caused inconvenience to power utilities, but have not been considered harmful to the systems or equipment. The consumer has not been aware of this type of trouble.

There are several forms of lightning strokes or discharges to which I shall refer briefly: sheet, fork or chain, and a third type, ball lightning. I have seen the ball form once only, many years ago, when it appeared in the early evening of a summer day on the prairie to several observers who were together during a very heavy thunderstorm accompanied by a rainfall verging on a cloud-burst. Two balls were seen, one three feet in diameter, and the other at least twice this size. When noticed, they were a few feet apart floating some fifty feet above the earth and gradually falling. They landed on a slight hill, the brow of which was not more than three quarters of a mile away, and quietly bounced once or twice like big rubber balls and then disappeared. When I visited the area the next morning there were no signs to be found to indicate the exact location. Whether this type of lightning is accompanied by thunder I do not know since there was at the time the continual noise of thunder from other lightning strokes.

The "sheet" form is an apparent misnomer. It certainly often appears as such to observers on the earth, but like many other things "appearances are deceiving." The illusion is produced by flashes of the fork or chain variety that occur between clouds, or between different parts within the same cloud, and since it is masked or veiled by the curtain of the cloud between it and earth, the whole cloud is lighted up giving us the name "sheet."

The "fork" or "chain" type gets its name from its shape. This may be seen at times between clouds, but usually much more distinctly when the flashes are from cloud to earth.

A lightning stroke makes itself evident through the eye as we see the flash. The discharge is usually accompanied by a noise we call thunder—the intense heat expanding the air with the violence of an explosion. The intensity of the noise, the length of the time the peal continues, and the time between the sight of the flash and the hearing of the sound are dependent on the magnitude of the stroke, its duration, and its proximity to the observer. When it is so close that, in addition to hearing the clap of thunder immediately following the flash, you also hear a sizzle—well, it is uncomfortably close. Sound travels at the rate of about 1,000 feet per second while light travels 186,000 miles per second. We see lightning from a great distance and hear it through the thunder for only relatively short distances. However, in these days we are aware of electrical storms at remote points through our radios, particularly short wave ones, by the static which accompanies many special programmes to which we would like to listen.

There is something spectacular about a storm venting its fury. An intense display of lightning at night is one of Nature's grandest spectacles. Lightning strikes terror, however, into many a man and beast, and if it is close, even the strongest of us will cringe. But when one is in a position to view it without danger, there is a majestic grandeur in watching the storm spending itself. Such a demonstration of power prompts one to ask, "Can lightning be harnessed?" No means has yet been devised to make it perform useful work, but we have learned how to intercept much of it so that its energy is dissipated without causing harm to life or property. Actually, there is comparatively little power in it, for the extremely short duration of any stroke limits the power content. Besides, in the 24-hour year-round basis there is relatively little in one location, that is, there is no concentation of supply where it could be collected. However, there has been a goodly share of romance connected with it for men have watched it with great interest and curiosity, among them Benjamin Franklin, who some 200 years ago used a kite in his determination to know something about it. What a thrill he must have had when, in accordance with his anticipation, the sparking occurred. Some discoveries are accidental, but many are the outcome of consistant, deliberate thinking. To the original searcher, when an expected phenomenon occurs, it is a confirmation rather than a surprise.

Lightning is so severe that it causes damage such as shattered trees, split logs, torn up earth, scattered rocks, the destruction of barns, and the loss of life. Some investigators have intimated that there are hot and cold lightning. This may be just another name for long and short strokes, as some strokes cause fire and some are just explosive. This is the initial damage caused by lightning, but the subsequent damage is frequently more widespread, such as the conflagration that it starts, the fact that a wall is shattered and that the wind accompanying the storm wrecks a building, or a tree or pole is knocked down, falls across a highway and causes an accident.

When the intensity of the electrical stress at any given location in air becomes sufficiently high, the air "breaks down," that is, becomes a conductor owing to its becoming ionized. This may be illustrated in the formation of "corona" in locations where the air is overstressed electrically as at "weak" points in an insulator string, or at points where breaks occur in ice encasing a conductor, or about a bare conductor. As the intensity of the electric stress is raised higher and higher, additional surrounding air "breaks down" until it propagates itself so far that an "arc over" to ground results. Power is required to initiate and sustain ionization. Additional power is required as the intensity of the electrical stress is increased and more ionization follows. Suspend the delivery of power and the ionization ceases, the ions present dissipating almost instantly. Lightning acts in a similar manner.

In spite of the great interest in the manner in which electrical charges arise in thunderclouds, the question is still controversial. Ascending currents of air and relative motion of rain drops of different sizes are usually assumed.

Thunderclouds have occasionally extremely low ceilings—a few hundred feet. Usually they are a few thousand feet in altitude and at times their tops are 30,000 to 40,000 feet and higher. This varies with the time of the year and the latitude.

In thunderclouds of average and great heights the temperature varies, going well below the freezing point and thus causing hail to form. Although there is always rain in even the small, isolated thundercloud, owing to the condensation of the moisture on account of the coolness of the upper air, it may not be in sufficient quantity to fall to the earth, particularly if it is over a dry area where it will all re-evaporate as it falls.

The electrical charge within a thundercloud usually concentrates in local areas and in relation to them the earth may be regarded as infinite in extent. As the charge accumulates in the cloud there is an opposite charge concentrating on the earth's surface directly below it. The intensity of the electrical stress in the air at the earth's surface, however, is comparatively low and the atmospheric pressure relatively high; while in the thundercloud the reverse is true. Thus the lightning stroke, when the charge becomes high enough, tends to be initiated from the cloud rather than from the earth. The "initial leader," "pilot streamer," or "leader stroke" seeks its way toward the earth (or a point of opposite potential in another cloud) in a series of steps, halting momentarily at the end of each when its power is temporarily inadequate, and awaiting a further charge from the cloud over a now prepared path of ionized air, when it will again leap forward as it propagates itself. The path of each step is usually straight but each new step is generally in a different direction, thus giving to "chain" or "fork" lightning the tortuous, characteristic path. "Branch leaders" occur frequently, but these may reverse and flow back into the "main leader" as it progresses, although when close to the earth they are likely to, and often do, form "side flashes" which are quite destructive making "hits" to otherwise guarded locations.

Once contact is made to the earth by the "leader stroke," an ionized path of low resistance exists through the air between the earth and the cloud and a "return stroke" with a heavy current flows from the earth to the cloud on this blazed trail.

A lightning stroke which appears to the eye as a single flash is, in reality, generally made up of a series of strokes that travel along approximately the same path. When the charge on the cloud is temporarily

depleted, the current ceases and the path seals itself off automatically by the ions dissipating from the path, that is, the dielectric strength of the air is restored to its virgin condition. All this occurs usually in not more than a second, 1,000,000 micro-seconds, a goodly portion of which was consumed during the establishing of the "initial leader" path from the cloud to the earth.

What actually causes the explosion when lightning strikes a tree? As stated, the actual power is limited but what there is is expended in an extremely short time. Thus, it acts like a hammer blow. A small path is made through which most, if not all, the discharge current flows. The heat of the stroke generates gas (considerable steam no doubt) and, since the time is so short, little if any of it can escape. Thus, high pressures are built up well beyond the breaking point and the explosion occurs. However, it usually subsides comparatively quietly, owing to the limited power, and in this is unlike a steam boiler explosion, where great volumes of steam instantly form, venting their destructive force once the pressure is relieved.

What causes the fire? Those of us who have kindled a fire know well that when conditions are ideal—dry, well-spaced, fine shavings—then the slightest touch of a match will light them. Should conditions be less ideal, then the match must be applied for a longer time. Lightning strokes, when they are sufficiently high in current and are sustained, may easily cause fire, particularly if conditions are ideal, in such places as a barn filled with hay on a day of a dry, hot summer. It takes time to ignite anything or even scorch it—the greater the heat applied, the shorter the time. One experiences this in everyday life in testing a sad iron, hot water, or hot milk.

What causes the loss of life when not in the direct path of the stroke, such as cattle under a tree? In one recorded instance, a herd of cattle appeared to have been quietly resting, some probably lying down, in the shade of a tree. When the lightning discharge current flowed into the earth at the base of the tree, differences of electrical potential existed between the ground directly at the base of the tree and points more remote—the farther away the greater the potential difference. Had an animal been lying or standing on an equipotential line it would probably have taken no harm, whereas if it was lying or standing facing toward or away from the tree, the ends of its body would be on points of ground at different electrical potentials—the closer to the tree the greater this difference. An electric current would then flow through the body and death would follow. In this case twenty-one valuable cattle were killed. Another and very plausible theory for the loss of the cattle is that, just previous to the lightning striking the tree, there was a considerable charge of electricity concentrated on the tree shared in a degree by all the objects in its vicinity.

When the stroke occurred, all the objects in the vicinity discharged, the charges of them passing to the ground and killing the animals. One experiences a similar shock after walking across a carpet and touching an object. I prefer the former explanation.

In the case of electric power lines and apparatus, there are both the initial damage from lightning and subsequent damage due to the heavy concentration of power from the system, which flows, one might well say pours, into the fault caused by the lightning and causes much more damage than the lightning. This subsequent damage is usually so extensive that it masks what the lightning itself actually did. This masking is a serious condition from the investigators' viewpoint but, as always, "necessity is the mother of invention" and a way was found to overcome the difficulty. A simple illustration is a string of suspension insulators where the top unit has been stripped of its porcelain petticoat and the conductor is marked.

Benjamin Franklin in his electrical experiments between 1740 and 1760 succeeded in identifying lightning as the static electricity of his time. Beyond this fact, little was learned until within the last thirty or forty years. The real incentive to obtain additional knowledge about lightning lay in the need of the electrical industry to protect against its effects.

Serious troubles were experienced from lightning causing apparatus failures and transmission line-outages when the art was in its infancy. Efforts were made to improve the service by installing special protective devices known as lightning arresters to drain off lightning currents from the system and associated apparatus in order to prevent if possible, and at least reduce, the damage caused by the accompanying high surge voltages. Ground or sky wires were also placed above the transmission line conductors. A measure of success resulted, but it was evident from mechanical defects in the devices themselves, and from the fact that they were at times destroyed by unusually heavy lightning discharges, that further investigation was necessary. The demand was accelerated by the era of rapidly expanding transmission systems and by service requirement becoming more rigid. Thus the need for reduction in outages due to lightning became more acute, placing more stringent requirements upon all protective equipment.

Of primary importance in the protection of power transmission lines and associated stations from lightning is a knowledge of the magnitude, duration, and wave-shape of the voltage and current surges appearing on utility systems. The characteristics of the stroke itself determine the resulting surges which occur on the electrical systems. Thus it becomes desirable to have instruments capable of measuring not only the system voltages and current, but also the properties of the stroke.

One difficulty in the development of such instruments is the wide range both in magnitude and time that must be covered. Studies, by research engineers, frequently in close co-operation with power utility operating companies, reveal that lightning stroke currents vary from a few amperes to 200,000 amperes. Also, that portions of the wave change so rapidly that time intervals of the order of micro-seconds need to be measured, while at the same time the duration of the complete stroke may be longer than one second, or 1,000,000 micro-seconds. Further, the mechanism of a lightning discharge has been gleaned from these records showing that it is initiated by a streamer or "leader stroke" followed by the main discharge, or "return stroke," which consists of one or more high current discharges of durations less than 100 micro-seconds and low amperage discharges lasting several thousand micro-seconds.

A number of special instruments have been devised to obtain the records from which these conclusions were drawn. They are known as the klydonograph, cathode-ray oscillograph, magnetic surge crest ammeter, Boys camera, and fulchronograph.

The Boys camera has a lense system which rotates with respect to the film and from its records can be deduced the direction and propagation of the stroke. Some of these cameras have a speed of 3,000 rpm. and permitted a resolution of the photograph of 0.3 micro-seconds.

The klydonograph, invented by J. F. Peters, is based on the fact, known for more than 100 years, that an electric potential applied at a point on a sensitized (photographic) plate or film would produce an image, called Lichtenburg figures, giving some measure of the magnitude, polarity, wave-shape, and duration of that potential. The instrument is simple and inexpensive and this permits its use in large numbers. A new form has recently been devised giving simultaneous positive and negative figures at the same point of contact on the system. The minimum critical voltage necessary to produce a figure is about 2,000 volts and the maximum that can be recorded is of the order of 18,000 volts. Klydonographs are commonly coupled with potentiometers to extend their application.

The cathode-ray oscillograph is the best instrument available from the standpoint of determining wave-shape of transients such as lightning surges. Its cost and complexity, however, limit its use in the field.

The magnetic surge crest ammeter is a simple, inexpensive instrument capable of measuring the crest-magnitude and polarity of surge currents. It has been used extensively.

The fulchronograph is also a relatively low cost device and has been widely used. It gives data regarding the wave-shape and the duration of the tail of current surges.

With the range of current, duration, wave-shape, and polarity of natural lightning known, impulse or lightning generators were designed and constructed which produced surges (sometimes referred to as tame lightning) similar to lightning strokes. Through the use of these generators, (now capable of producing 10,000,000 volts) "the art" has been able to obtain a greatly accelerated knowledge of the characteristics of the initial damage caused by lightning which has resulted in:

(1) The production of electrical power apparatus with a greater immunity to breakdowns due to actual lightning. Failures now occur relatively seldom and those which do may be attributed to the rare, unusually severe, direct strokes or to undetected deterioration having weakened the materials.

(2) The production of lightning arresters with adequate safety valve capacity.

(3) The establishing of optimum locations for the ground wire over transmission lines and the ground shields over the station in an effort to exclude the lightning entirely from the power system.

Since a practical application must always be made, the safeguarding of the electrical service against lightning still falls short of the ideal. Should lightning now cause a failure, be it in apparatus or on a transmission line, the "fault" is promptly separated from the system in the minimum of time by the functioning of the protective relaying to open all supply circuits to the faulty section. Because this limits the subsequent damage to a minimum, and very often prevents it, it is usually possible to resume service on the isolated section as fast as the operator can act—say within a minute. Thus the whole system is again normal and fully ready for the next emergency. The prompt restoration has proved of great value to continuity of service, particularly when an unusually severe thunderstorm is crossing a vital portion of the system.

To sum up, as citizens we owe much to scientists and engineers who have now reached the point where they are convinced that these troublemakers of Nature have had their worst sting removed. It can be said, fairly, that it is now a very unusual occurrence for "Hydro" consumers to have a major interruption in their service. In the meantime, more knowledge is being acquired every day which means, in turn, that more effective precautions can be taken in the future. We will never be able to prevent violence in Nature, but so long as we can safeguard our own interests we have little need to worry.

In "The Elements Rage" Frank W. Lane states, quoting from Dr. W. J. Humphreys, Sir Lawrence Bragg, and others:—"But it would be an

error to imagine that lightning is merely a glorified firework display which occasionally kills and damages, but brings no benefit to humanity. By a process similar to that used in nitrogen-fixation factories, lightning, employing sparks thousands of feet in length, manufactures fixed nitrogen from the air, and this is deposited on the earth with the rain. According to Humphreys (1937) the amount of nitrogen compounds produced in this way amounts to 12 lbs. per acre per year—or some 770 million tons of 100 per cent pure natural fertilizers. Other estimates, however, put the annual total at only 100 million tons. In this connection it should be remembered that there are probably 16 million thunderstorms a year throughout the word. According to Bragg 1,800 are taking place somewhere at any given moment." Again, "In this connection the greenness of pasturage after heavy thunderstorm rain may be noted."

Accordingly it would be well for all to remember that "God maketh His sun to rise on the evil and good, and sendeth rain on just and unjust."

Yes, "There's a wideness in God's mercy
Like the wideness of the sea;
There's a kindness in His justice
Which is more than liberty."

And, "God moves in a mysterious way,
His wonders to perform;
He plants His footsteps in the sea,
And rides upon the storm."

"Along the Milky Way"

HELEN SAWYER HOGG, A.M., Ph.D., F.R.S.C.

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November 9th, 1946.

Practically everything that can be seen in the heavens by the unaided eye is included in the Milky Way. Our solar system with its sun and nine planets is somewhere near the perimeter of this galaxy and revolves around it once in two hundred million years.

The distance from the earth to the moon is about one light second; from the earth to the sun, about five light hours. The diameter of the Milky Way is over a hundred thousand light years. It is composed of

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Page 30—"Along the Milky Way." Paragraph 2, line 2, for "the sun" read "Pluto."

some fifty thousand million stars and unformed matter with a total estimated mass equal to another fifty thousand million stars.

Due to this inchoate mass it is impossible to make observations through the centre of the Milky Way. But globular clusters of stars, fortunately outside this central obstruction, enable astronomers to deduce the dimensions of the galaxy and also its shape, which may be compared to that of a grindstone, bulging in the middle and tapering towards the rim.

More than a hundred such globular clusters are known, some of them containing half a million stars, which clusters, to the unaided eye, appear as but single points of light. One cluster is one hundred and seventy-five thousand light years away, but it cannot be said definitely whether it belongs to the Milky Way or to another galactic system.

Astronomically, another great aid in measuring the galaxy is afforded by the periodic variable stars which increase and decrease in brightness with precise regularity that can be worked out to the one hundredth of a second. In astronomy observations are now made almost entirely by photography. One night's photographic observations may mean weeks of analysis of the plates. A ten minutes' exposure may photograph an image which is ten thousand times fainter than can be seen by the unaided eye.

Regarding the inchoate mass of matter which is distributed through the Milky Way and is referred to above, it is an interesting speculation whether this represents the process of the formation of stars or their dissolution. One of the important problems occupying the attention of astronomers concerns the vast patches of light-absorbant matter which is meshed through this unformed mass. Previously these areas of blackness—which constitute ten per cent of the Milky Way—were thought to be holes in the heavens through which we looked into empty space. Through improvements in astronomical instruments, notably the infra-red photographic plate, it is now ascertained that these dark patches are masses of matter which absorb rather than reflect light.

As mentioned, almost everything that can be seen in the heavens by the unaided eye is included in the Milky Way. There is, however, an exception; the neighbouring galaxy of Andromeda. It is seven hundred and fifty thousand light years away.

"Digging up Ontario History"

The Archaeology of Cahiagué, where Champlain met the Hurons.

T. F. McILWRAITH, M.A., F.R.S.C.

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November 16th, 1946.

Probably few small forays have had greater historic results than the one made by a party of Huron warriors accompanied by Champlain and some French soldiers which set out from Cahiagué village, near what is now Orillia, Ontario, in the summer of 1615, to attack the Iroquois in what is now upper New York State. The engagement itself was inconclusive. Few were killed or wounded on either side. But the attack definitely allied the Hurons with the French and the Iroquois with the English.

This alliance may well have had a later decisive part in the ultimate fate of New France. The location of the Huron village of Cahiagué is therefore a matter of historic interest. Champlain's own description of the village is vague and its definite identification would appear to be a task for archaeologists.

In the late summer of 1946 the Royal Ontario Museum of Archaeology with the co-operative support of the Orillia Board of Trade conducted archaeological work on a large Huron Indian site near Warminster in the northern part of Simcoe County. The results seem to establish the site as that of the village of Cahiagué. Its location conforms to Champlain's references and the nature of the fragments recovered indicates that the village was occupied at the time of the earliest European contact.

The dimensions of the site, which is more than half a mile long, are consonant with a village of about 200 houses and between 4,000 and 5,000 population. It was located on a sandy upland with ravines on either side in which were dumped the ashes from the house fires. A mound in the centre of the village proved to be an ash pit in which the debris had been deposited in reasonably regular strata thus even more definitely demarking the periods before and after the coming of the French. Down the slope of the ravines the refuse and ashes extended for a depth of 100 feet.

By careful trowelling in these refuse heaps more than 9,000 pieces of Indian pottery were recovered as well as many fragments of pipes, stone and bone tools, wampum, and shell ornaments. In the upper levels were found beads and pieces of copper kettles and iron goods indicating the presence of the early French. Such items as heavy axes and better beads,

which would have indicated the presence of the French at a later date, do not appear.

Most Huron villages of this type existed for only about ten years, in which time the fields and firewood became exhausted. For this reason Cahiagué had been abandoned when the Jesuits arrived some twenty years after the visit of Champlain. The value which the natives attached to the European trade goods is shown by the care with which scraps of iron had been fitted into bone handles and the way in which small fragments of kettles had been fashioned into ornaments, tools and arrow heads.

At the end of the village an ossuary was excavated. This pit measured about eighteen feet in diameter and six feet in depth and was an almost solid mass of bones. It was an evidence of the Hurons' greatest ceremony, the Feast of the Dead. Every ten years the tribe collected the bodies of those who had died in the preceding decade and with great lamentation placed them in a common pit—"a mingling of friends forever." This ritual insured that the dead would go together to the next world, and provided the survivors with the opportunity for a communal service of great emotional significance. They were buried with objects of value such as shell and copper ornaments, and French beads.

Two complete skeletons were recovered. The evidence shows a high percentage of children's deaths. Dr. P. W. Arkle of the Faculty of Dentistry, University of Toronto, is studying the teeth found in the ossuary and a preliminary examination reveals a high proportion of caries, much greater than in the teeth of members of the hunting tribes. This observation leads to the speculation that the condition may have resulted from diet which consisted mainly of corn and maple syrup.

"Timing as a Factor in War"

HIS EXCELLENCY
FIELD MARSHAL THE RIGHT HONOURABLE THE VISCOUNT ALEXANDER OF TUNIS, G.C.B.

Governor-General of Canada.

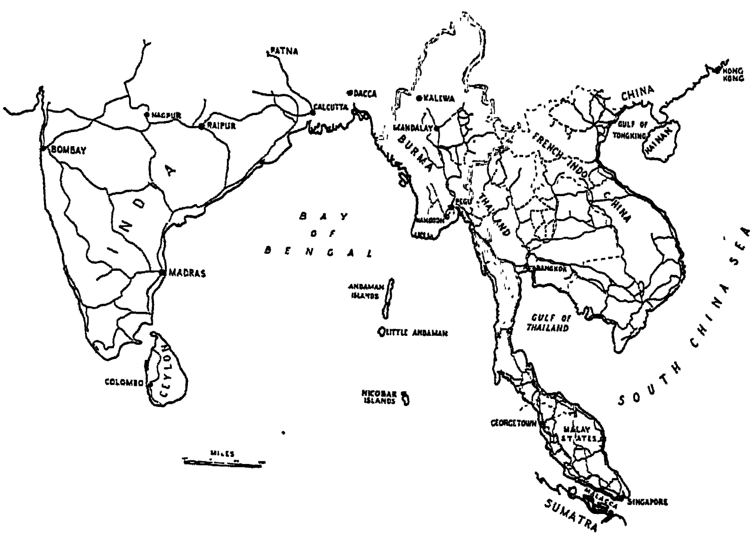
November 23rd, 1946.

My subject this evening is "Timing as a Factor in War," and I propose to illustrate this by examples from the campaigns I fought between the years 1942 and 1944, which show the effect it had on the results of those campaigns.

Napoleon made this well-known remark:—"Go, Sir, gallop and don't forget the world was made in six days. You can ask me for anything you

like but Time." When the Emperor said this, he was in a hurry, but I warn you that the correct use of Time does not necessarily mean "hurry." To strike before you are ready and balanced is generally futile and may lead to something worse than failure. To strike too late is also futile and means that you have missed the bus. Correct timing, therefore, is the result of a careful appreciation of all the factors and a weighing up of the various pros and cons of the situation.

If the correct use of Time can be allied with surprise, you get the best of all conditions for success. Surprise, of course, pre-supposes that you strike at the right moment, when the enemy is taken off his guard. By such a manoeuvre you should at least gain a local victory, but the gaining of that local victory may not be in the best interests of the campaign as a whole. Consequently, we see that the element of surprise is of value only if it is timed correctly—that is, if the right moment is chosen to let the surprise packet out of the bag. In the following examples which I propose to demonstrate, you will note that the use of Time as a winning factor is more from the strategic angle than the tactical, the difference between strategy and tactics as interpreted by Clausewitz being that, "whereas Tactics is the employment of military forces for the purposes of the battle, Strategy is the employment of battles for the purposes of the campaign." The theatre of war is the province of Strategy. The field of battle is the province of Tactics.

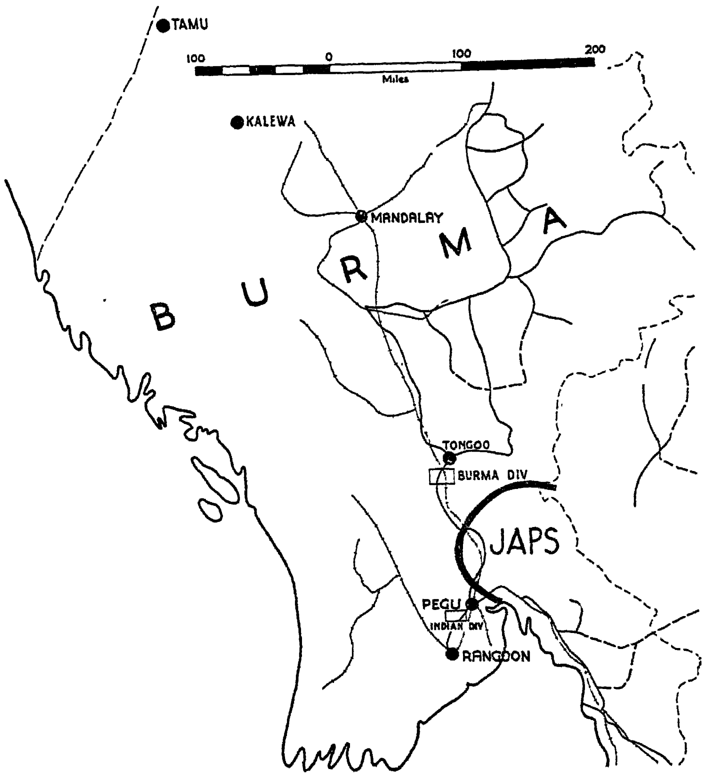


Map 1.

THE BURMA CAMPAIGN.

My first example is the campaign in Burma in 1942. Things had not gone well with our army there. There were many reasons for this which I do not propose to go into, because they do not concern us this evening.

But when I landed by air to take over command at the beginning of March, I found the situation as illustrated in the first two maps. Map one shows the position of Burma in relation to India and China and to Indo-China, on which the Japanese Forces were based and from where they started their drive on Burma. Map two shows the position of our Forces vis à vis the Japanese when I took over command at the beginning of March, 1942.



Map 2.

It will be seen that the Burma Army consisted of two Divisions. First, there was the 18th Indian Division at Pegu, which had been badly hammered, was tired and weak in numbers and only had about twenty remaining 18-pounders out of its proper establishment of seventy-two. Secondly, eighty miles away, at Tongoo was the so-called Burma Division, which had seen little or no real fighting, but which was sadly depleted in numbers owing to the large percentage of deserters who had gone over to the Japanese with their arms. The Japanese invader had infiltrated and was continuing to do so between these two Divisions into the hills and forests between Tongoo and Pegu. The Chinese armies which were no bigger than half our Divisional establishment—with really nothing more than a rifle to every three men and a very few automatics—was still away to the North.

This was the situation I was faced with when I arrived. It was clearly obvious that the first thing to be done was to try to regain the initiative. With this in view, I ordered the 18th Indian Division to attack northeast and the Burma Division to attack south with the object of gaining a junction. Once my forces were united, I could either re-establish the position on the Sittang River or, if I were not strong enough to affect this, fall back to a position covering my base at Rangoon and await further reinforcements.

Both attacks failed and, in fact, made little or no progress. One of the main reasons for their failure lay in the fact that neither Division was trained in jungle warfare and both Divisions were on a mechanized basis, with the result that they could not operate off the roads. As there are only two roads in Burma, one from Rangoon to Mandalay via the Tongoo Valley and the other via the Irrawaddy Valley, it is not an exaggeration to say that the Burma Army was wrongly equipped and organized for fighting in this part of the world. Worse than failing to regain the initiative, I was now faced with possible disaster when superior Japanese forces, moving to our rear, entered Rangoon behind our backs and cut us off from our base. As there were no roads or communication with India, Burma from that moment was lost to us.

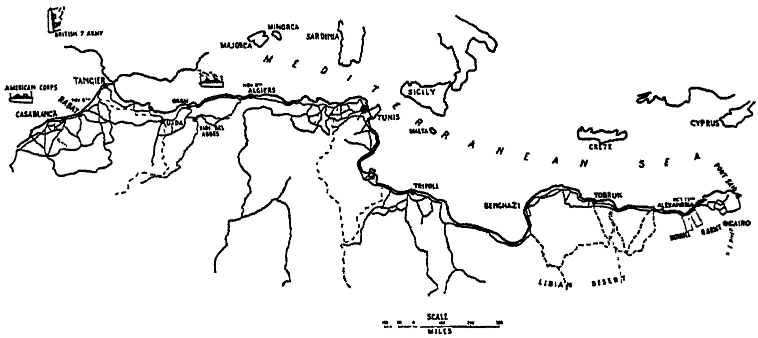
The problem now facing me was: could I save my forces and, with them, India from invasion, India being at this time unprepared for a threat to her eastern frontier. And nothing stood between India and the Japanese but my small and battered army.

Time was the answer to that problem. I knew that if I could keep my forces intact I could fight a delaying action back up Burma towards the Indian frontier, and if I could hold the Japanese off for three months, until the monsoon would break, India would have those three months plus four or five during the monsoon period in which to prepare and organize her defences. But Time was also operating against me, because, having no base, I had no supplies of petrol, ammunition, food, etc., except those I carried with me, plus a few dumps in the north of Burma and what food I could collect from the country-side. Hence, I could only keep the field for a strictly limited period.

I will not relate the story of the retreat through Burma with all its battles, hazards and difficulties, as it has little to do with my lecture, suffice it to say that by the help of the Almighty, allied to a good deal of luck and correct Timing, the Burma Army arrived more or less intact on the frontiers of India just as the monsoon broke. And so ended the first Burma Campaign in June 1942. It was a military defeat but not a major disaster.

My next example where Time was a dominating factor is a very different tale to tell, because it is the story of a victory.

When I flew to Cairo in August, 1942, to take over command of the Middle East Forces, Winston Churchill gave me a directive of which this is the relevant sentence: "Your prime and immediate task is to destroy Rommel and his German and Italian Armies together with all their organizations." Although it was not written in my directive, I was told verbally that it was essential to our war strategy that a clear-cut decisive victory



Map 3.

must be gained before November 8th, because on that date, November 8th, the Forces under General Eisenhower, consisting of the British 1st Army and an American Expeditionary Force, sailing direct from England and the States, was due to land on the shores of North Africa. To facilitate their task of invasion by swinging North Africa over to the side of the Allies, a decisive victory over Rommel must be gained, and gained in time for the news to circulate and influence French public opinion and action.

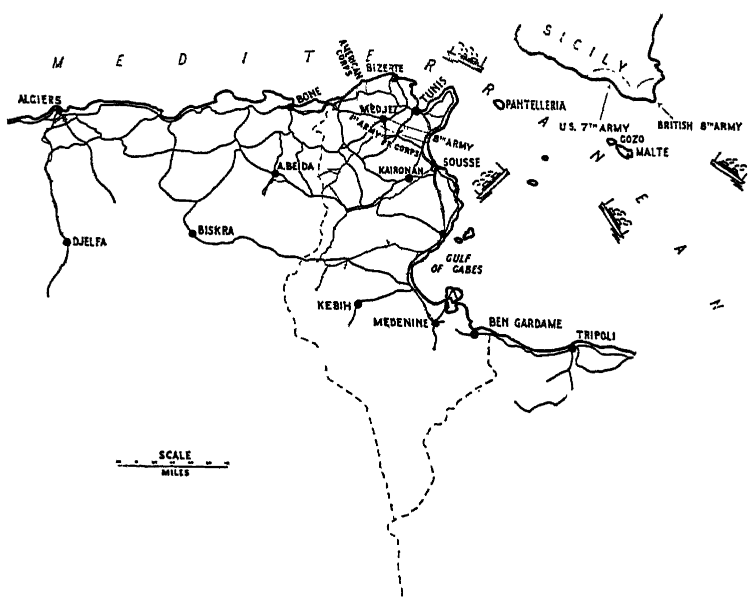
To gain a decisive victory over an enemy as strong and experienced as Rommel required careful planning and time to prepare, and my task was made more difficult because so much had to be done and the time was all too short within which to do it. I had about two months in which to re-organize, equip and train an army which had suffered defeat and which was on the defensive, and, in addition, to plan, prepare, and rehearse an offensive operation which had at all costs to succeed. At this period, reinforcements in men, material, and modern equipment began to arrive and for the first time in the war we were in a position to build up a force strong enough to face the Germans on level terms.

All was going well, but in September Rommel made his final bid to reach the Nile Delta. The battle lasted a week, the front held, and Rommel withdrew to his start line. This was a tactical success for us,

but it not only delayed my preparations by a week, but cost me considerably in men and material. Although I had planned for the big offensive to be launched about the first or second week in October, Rommel's attack had put us back in our preparations by at least a fortnight, which meant that the opening date of the big offensive could not now take place before the end of October. As victory had to be gained before November 8th, this I admit was running it fine, but as luck would have it, this later date for the opening of the battle of Alamein had one advantage, in that it gave us a waxing or a rising moon, a very useful asset in offensive operations.

At this period there was much pressure put on me to launch the offensive at the beginning of October. If I had agreed to do this, then I think the battle of El Alamein would not have been won, because as I said earlier, to strike before you are ready is to court failure.

The battle was launched at 11 p.m. on October 23rd, and although it was a ding-dong struggle for eleven days and nights, in which victory was gained only by the employment of our last reserves, Rommel and his Afrika Korps were decisively beaten on November 4th, four days before General Eisenhower with his Anglo-American Forces landed on the shores of North Africa. Within the framework of the big strategic picture, Time had been our dictator and we had won out on a short but sufficient margin.



Map 4.

THE BATTLE OF TUNIS.

The third case I propose to take is the Battle of Tunis, which ended on May 13th, 1943, with the elimination of the Axis expeditionary forces

under General von Arnim, numbering some 300,000 men, and the freeing of the whole of North Africa from Cairo to Casablanca.

The object of the Battle of Tunis was twofold. First, to open up the Mediterranean to our shipping. Secondly, to gain a springboard for an assault on Southern Europe, and that springboard had to be ready for us sufficiently early to allow the mounting of an overseas expedition of two armies to capture and consolidate the island of Sicily during the settled weather of that summer. When I took over command of the Anglo-American and French Forces on February 19th, 1943, I had just under two months in which to eliminate the enemy from Tunisia because, as was calculated, the middle of May was the latest date we could afford to go to, if amphibious operations were to be undertaken against Sicily that year.

After a careful study of the situation, I came to the conclusion that, to overcome such a formidable enemy as we were faced by, the fullest and closest co-operation with all our Naval and Air Forces would be necessary. The Germans and Italians were very strong in numbers and, further, they were operating on interior lines, whilst we were operating on exterior lines. But our enemy had one weak spot and that was his lines of communication across the sea from Tunis to Sicily and Italy. I knew that if I could cut these, he would fall an easy prey. However, the Navy could not operate against the enemy's supply lines without fighter cover, and the Air Force could not give them fighter cover until we could get airfields within striking distance of Tunis and Cap Bon.

The first move, then, was to stage a series of battles which would force the Germans to fall back to a shorter perimeter covering their main base at Tunis. The Germans are good soldiers and no doubt foresaw the danger to themselves which lay ahead, but they were not able to prevent my 18th Army Group from pushing them back to a shorter line and when I got them back to the position which is shown on the map, I knew that I had victory in my pocket. With the hasty construction of airfields well forward we were able to put our strong Anglo-American bombers and fighters into the air and gain that air superiority which is the first step to winning a battle.

The next step was to organize the fighter cover for the fleet which would allow the combined navies to operate against the enemies' supply lines. When this desirable state of affairs had been achieved, von Arnim found himself isolated in North Africa, cut off from his home base, and unable to get anything in or out of Tunis, either by day or by night.

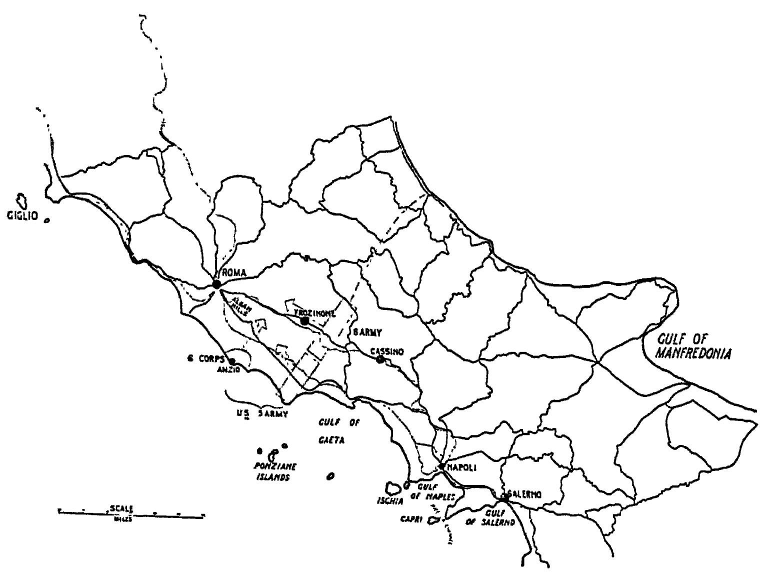
What I learned in Burma, I applied in Africa, but with this difference, where I had played for time against the Japanese, I now had to play against time in Africa, because I had to win my battle by not later than

the middle of May, and the sooner I won it, the more time I would have to plan and prepare the invasion of Sicily. With this in view, I delivered the final assault in late April. The spearhead of my attack was two infantry divisions on a 3,000 yard front, supported by all the artillery at my disposal, followed closely by two armoured divisions, which went slap through to Tunis, a distance of thirty miles, in thirty-six hours. This split the Axis in half and drove a dagger into the heart of the defence. The Germans and Italians surrendered to the tune of 248,000 men (only 600 odd got away). The battle was won and North Africa was completely cleared of the enemy by the date I had worked to. Once again, Time had been the dictator in my planning.

The Battle of Rome.

My last example is the Battle of Rome. Somewhat like El Alamein, the battle for Rome was dictated by Time. My directive from the combined Chiefs of Staff was to capture Rome before the Western invasion was launched, so as to strike a blow at German morale and to raise that of the Allies, especially those who were about to cross the Channel.

The Western invasion was set for the first week in June, 1944. In Italy, owing to climatic conditions, that is the state of the weather as it



Map 5.

affected our air forces, swollen rivers and muddy ground as they affected our ground forces, a full-scale offensive could not get off to a good start before early May. The 8th Army still lay fifty miles south of Rome, and I had only one month of fighting within which to accomplish my mission.

Now I do not wish to stress this aspect of the time problem, because, although the capture of Rome was important for the reasons I have given, the primary object of the Italian spring offensive was to destroy the German armies under Kesselring; and the time aspect which I wish to stress here is in its application to the winning of the battle which I am now going to describe.

The situation at the beginning of May, 1944, was as indicated on the map in figure five. The 8th Army, consisting of some eleven divisions, was secretly concentrating in the mountains between Cassino and Naples. The American 5th Army had six divisions in the Anzio bridgehead, whilst the French Corps and an United States Corps were posted on the left of the 8th Army. These dispositions gave me the opportunities of a double-handed punch—a method of manoeuvre which I much favour, since, if properly employed, it enables one to gain and maintain the initiative and opens up the possibilities of double encirclement by a pincer movement. But, and this is the point, its success depends entirely on timing the blows of the right and left punches correctly, which was accomplished in the case in question as follows:

Knowing that the Germans expected the main attack to come from Anzio and were unaware of the strength of the 8th Army's concentration opposite the Liri Valley, I led off on May 11th with a heavy assault into the Liri Valley on the Cassino front. As I anticipated, the Germans did not expect this to be anything more than a holding attack, with the result that the 8th Army penetrated not only the German winter line, but the Hitler line as well. This opened the road to Rome from the South, and Kesselring, realizing the danger to his defence from the strength and magnitude of our attack on the main battle front, immediately reacted by withdrawing divisions from the Anzio bridgehead to try and stop our advance in the South.

This, of course, was what I had been hoping and manoeuvring for. My problem now was to time the break-out from Anzio. If I struck too soon, the 8th Army and the 5th Army would be out of supporting distance of each other and the resulting operations would develop into two separate and isolated battles. If I delayed too long, I might miss the opportunity of breaking out from Anzio, where the withdrawal of German divisions for the main battle front had left their defences opposite the American 5th Army dangerously weak. There was one further complication to the time problem, namely, that General Truscott, who commanded the Anglo-American Forces in the Anzio bridgehead, wanted 72 hours warning before he made his break-out so that he could make his secret concentrations under cover of darkness, and gain surprise for the point of his attack. Consequently, in choosing the moment for Truscott to strike, I had to anticipate the situation as it would be three days ahead, and calculate where the 8th Army would have reached and the probable strength and disposition of the enemy at that time.

It is arguable if there is such a thing as luck, but if there is such a thing, it was on our side, because when the 5th Army launched their attack from the Anzio bridgehead, they struck at the very moment when the last German battle group to be withdrawn from that front was in process of moving to the South against the 8th Army, with the result that it took no part in either of the succeeding vital engagements. Kesselring, caught in a pincer movement and facing disaster, ordered a general withdrawal of those forces which he could extricate. The Germans had suffered a major defeat, and the Allies entered Rome on June 4th, 48 hours before the Anglo-American invasion landed on the shores of Normandy.

I would now ask you to cast your minds back to the four examples I chose to illustrate my address, and you will see that:

In Burma we played for time.

In North Africa we played against time.

In Italy we played with time.

There is one other and perhaps classic example of the influence of Time on military operations that I feel I must include, although it is outside the scope of my lecture. It is the Greek Venture in the early days of the war in the Mediterranean. You will remember that after Lord Wavell's success in the Western Desert at the beginning of 1941, troops which included the New Zealand Division under Freyburg were taken from Libya and hurriedly dispatched to go and help the Greeks. The results in both theatres were unfortunate. In Greece we were not strong enough to prevent the Germans from over-running the country and in consequence we suffered another military defeat. In Libya results were little better. Too weak to hold the positions reached at Bengazi and Agedabia, we were soon forced to fall back to the Egyptian frontier at Solum.

There was considerable criticism of our strategy at the time. Many people felt that a great mistake had been made in weakening one front where we had been successful for the sake of another where we proved to be too weak, with the inevitable consequence of falling between two stools. We need not concern ourselves to-night over the rights or wrongs of the case. From a purely military point of view it may be considered to have been unwise, but in higher strategy all sorts of things have to be taken into account; such as, psychological reactions on friend and foe, national prestige, morale, politics, and so on.

The interesting point is that Hitler's attack on Russia was delayed by six weeks owing to our move into Greece and its threat to the Axis position in the Balkans. The Germans did not dare to launch this offensive against the Red Army until their right flank was secured. Of course,

at the time the decision was taken to send troops to Greece, we did not know that Hitler intended to attack Russia, so our leaders can take no credit for the correctness of their decision in this respect. But that six weeks delay imposed on the German Army meant the loss of six weeks good campaigning weather in Russia. Hitler just could not make it in time. The Russian winter came down as the German Army arrived on the outskirts of Moscow—and who can tell what would have happened to Russia if they had lost Moscow. I wonder if Hitler said to his generals, as Napoleon had done a century and a half earlier: "Go, gallop Sir, you may ask me for anything you like but Time."

I did not select this subject for my address only to recall the drama and glory of the battles of the past, the records of which now belong to the pages of the history books, but to illustrate to you that this time factor influences our very lives and actions, and is just as potent a factor for success in business, sport, politics or, indeed, the art of living, as it is on the field of battle.

"The Story of the Connaught Medical Research Laboratories, University of Toronto"

R. D. DEFRIES, C.B.E., M.D., D.P.H.

Director of the Connaught Medical Research Laboratories and the School of Hygiene, University of Toronto.

November 30th, 1946.

The story of the Connaught Medical Research Laboratories commences in 1913, a year before the work was formally undertaken in the University. At this time Dr. John G. FitzGerald, a graduate of the University of Toronto, came back to the University following an extended period of research in Europe and the United States. He had studied the work of the Pasteur Institute in Paris and Brussels, of the Lister Institute in London, and the laboratories of the Health Department of the City of New York.

Dr. FitzGerald knew that the lives of thousands of diphtheria patients could be saved by having serum diphtheria antitoxin available at a price which would permit its use in every case. He believed that of even greater importance was research to find a practical means of preventing diphtheria.

His ideas were novel and not immediately acceptable. But on his own Dr. FitzGerald built a little stable on Barton Avenue, Toronto, to house five horses, with a small operating room to permit of their treatment, and commenced the preparation of the antitoxin serum. Within a few months Sir Edmund Osler, a member of the Board of Governors of the University who had become keenly interested, offered personally to meet any deficits in the work. Sir Edmund's interest led to the work being started on May 1st, 1914, in the Department of Hygiene in the Medical Building where laboratory space was provided in the basement and sub-basement.

A few months after the outbreak of the first Great War the need for tetanus antitoxin—the serum to prevent lockjaw—was recognized by Army authorities. Colonel (later Sir Albert) Gooderham, on behalf of the Canadian Red Cross Society, approached Dr. FitzGerald to learn whether this serum could be made here. It was at that time that the present Director joined Dr. FitzGerald in undertaking the preparation of this serum. Colonel Gooderham became greatly interested in the work of the Laboratories and to meet the urgent need for accommodation he purchased a farm property of fifty-seven acres and had erected a modern laboratory building and a superintendent's residence, costing in all $100,000. The Dufferin Division of the Laboratories, as it is now known, has 145 acres with more than twenty buildings and employs 175 persons.

During the first World War more than 250,000 doses of tetanus antitoxin were supplied, a half million doses of smallpox vaccine, and quantities of serum for treating epidemic meningitis.

After the discovery of insulin by Banting and Best in 1921, the Laboratories found space for its large-scale production in a building on the University grounds which had housed the University Y.M.C.A. In connection with insulin, a very important development was the addition of a trace of zinc to insulin and protamine designed to prolong its effects and developed by Dr. D. A. Scott, who also did important work in the development of heparin, a substance which is of great value in surgery preventing the clotting of blood.

Another great discovery in the years between wars was the preparation of diphtheria toxoid, a successful protection against the disease. In the following year diphtheria toxoid was made available by the Laboratories to all provincial departments of health throughout Canada, which country continues to lead in the prevention of diphtheria. Later, under Dr. P. A. T. Sneath in the Laboratories, tetanus toxoid was prepared. This work made possible the supplying quickly of the large quantities of this preventive of lockjaw in the second World War.

In 1935 a Western Division of the Laboratories was estabished in

the University of British Columbia. Thus the conduct of research work in the Connaught Laboratories is not limited to the University of Toronto. Further, its medical public service in the preparation and distribution of essential public health biological products extends throughout Canada.

In 1924 The Rockefeller Foundation made possible the establishing of a school of hygiene in the University of Toronto through a grant of $650,000, and as the Connaught Laboratories provided that interest which is so essential to the successful development of post-graduate teaching, namely research, it was arranged that a building be erected which would accommodate both the school of hygiene and the section of the Connaught Laboratories which had been located in the Medical Building. Its size was later increased by more than fifty per cent.

At the commencement of the second World War, the staff of the Laboratories numbered 258 and in the last year of the war this number had increased to 950, indicating the extent of the development of the work during the war. Research on influenza has been carried on at the Laboratories for ten years, and during the last year of the war a vaccine was prepared for the armed services. Much more work is required and more observations as to its preventive value are needed before the measure can become a general public health procedure. In the last war tetanus toxoid replaced the use of serum and the Laboratories furnished all required for the protection of our Canadian troops. A combination of tetanus toxoid with typhoid-paratyphoid vaccine gave the forces the double protection in one series of inoculations. The development of T.A.B.T., as it was called, was one of the most significant contributions made by the Laboratories during the war. One thousand horses were employed in the preparation of a serum which contained the protective substances against the several types of gas gangrene bacteria which were causing serious wound infections in the armed forces.

Studies were carried forward under the direction of Dr. James Craigie which made possible the supplying of typhus fever vaccine for the protection of approximately ten million persons and constituted one of the major contributions of Canada in the war.

In 1943 the former Knox College building on Spadina Crescent was rehabilitated for use as laboratories for the preparation of human blood serum and for the production of penicillin. A total of 500,000 bottles of serum was furnished by the Laboratories, representing the processing of more than two million contributions of blood. The Dominion Government asked the Connaught Medical Research Laboratories to undertake the preparation of penicillin on a large scale. The quantity required was furnished well within the time arranged and the work has continued to be

extended and important research studies have been made. Large quantities of penicillin are being prepared and distributed.

The work to-day demonstrates the soundness of the judgment of the late Dr. FitzGerald and the effectiveness of his planning. Those of us who have been privileged to carry forward the work have had the inspiration of his faith and leadership.

"The Development of Atomic Energy"

J. R. DUNNING, Ph.D

Director of the Division of War Research, Columbia University, New York.

December 7th, 1946.

The most important future contribution of nuclear energy for peaceful purposes will consist, probably, in utilizing new types of super fuel. The fuel found in nature is U-235, an isotope of uranium occurring in relatively minute proportions in common uranium, which is largely U-238 U-235 is the stepping stone to the future atomic age.

Measured in British Thermal Units, one pound of U-235, having a volume of only one cubic inch, will release as great heat as three million pounds of coke or eleven million kilowatt hours of electrical energy. In the practical application of nuclear energy there are the problems of separating U-235 from ordinary uranium, the control of the temperatures of its fires, and the transmission of this heat into power while at the same time providing protection from dangerous radio-activity.

The problem of separating U-235 from U-238, in its solution, involved the construction at Oak Ridge of the largest single industrial plant ever built. The separating process is based on the difference in average speeds of the molecules of U-235 and U-238—a difference of only four-tenths of one per cent. The method is known as gas diffusion. A uranium gas is passed through a porous membrane. The U-235 gas passes through more rapidly thus providing the condition for separation from the heavier gas; but several thousand such stages are necessary to recover pure U-235. The whole process extends for seventeen miles on one floor of the building and employs a technology totally new in engineering. It is so nearly automatic in operation that it runs almost entirely without personnel.

U-235 in burning produces a new fuel, Plutonium, from U-238, which opens up possibilities of further and cheaper application of atomic power.

Similarly, another possible new fuel, U-233, may be produced from thorium which is relatively abundant.

The temperature of the atomic fires is controlled by regulating the extent of the chain reaction, i.e., the successive "generations" of the released neutrons which fission adjoining nuclei.

In the use of nuclear energy there is a heat exchange rather than combustion, as in the use of chemical energy, thus the combustion chamber is eliminated; but as a protection against radio-activity, shields of from six to eight feet thick are necessary. For this reason mobile atomic energy plants appear to be impracticable except for such large moving units as steamships or submarines.

But it is possible that within the foreseeable future nuclear energy will change the economic and social outlook over the world. It may bring energy to places now inaccessible to sources of power and facilitate developments of natural resources now impossible. Its use in Canada and other countries with large cold areas may well be important, especially in eliminating the necessity of transporting coal, oil or electric power over long distances.

"Through the North-West Passage"

V. A. M. KEMP, C.B.E.

Formerly Assistant Commissioner, Royal Canadian Mounted Police.

December 14th, 1946.

Almost since the time of Columbus the North-West Passage has been a challenge to explorers. It was sought by Cabot, who did in fact reach Baffin Island. It beckoned the ill-fated Franklin expedition on to its doom; and the twenty years of search for this lost party added much to the knowledge of Arctic navigation, making no small contribution to Amundsen's successful voyage in 1903-1906 from east to west.

The two voyages of the Royal Canadian Mounted Police schooner "St. Roch" through the Passage, first from west to east and later from east to west, were not undertaken as an adventure in exploration or as a stunt. They were in the line of duty patrols, perhaps more spectacular and far-flung than other patrols, but they were nevertheless, embarked upon as police work, the purpose being to visit places inaccessible by other means and to maintain Canadian sovereignty in these areas.

The schooner "St. Roch" is 105 feet in length and 25 feet beam, of Douglas fir sheathed with Australian iron bark as further protection against ice. She is powered by a diesel engine and has auxiliary sails. She has a cruising speed of eight knots. On both voyages the "St. Roch" was under the command of Sub-Inspector H. A. Larsen, perhaps the greatest living Arctic navigator.

The first voyage from Vancouver to Halifax, extended from 1940 to 1942. It proceeded by way of Bering Strait, Beaufort Sea, Walker Bay, Pasley Bay (where it wintered) and around the Bothnia Peninsula. While at Pasley Bay, one of the personnel died and Sub-Inspector Larsen mushed 800 miles to summon a priest to conduct a Christian burial. It was referred to in his report with characteristic understatement.

On leaving Pasley Bay the worst part of the voyage was encountered. It took 26 days to travel the 140 miles to Bellot Strait. The vessel was imprisoned by pack ice, the worst menace of Arctic navigation and tossed by severe gales.

When the "St. Roch" arrived at Halifax early in 1942 she had travelled some 10,000 miles from Vancouver. In July, 1944, she left Halifax for the return voyage through the North-West Passage and arrived at Vancouver in October of the same year. On this occasion she followed a more northerly route through Lancaster Sound, Melville Sound, and the Prince of Wales Strait. In the delta of the Mackenzie River, at one of the settlements, the inhabitants at first refused to come to the waterfront to greet the "St. Roch" because, as it was later learned, they feared she was a Japanese ship.

The "St. Roch" may have many more years of useful service to the Royal Canadian Mounted Police. But when the time comes to dispose of her, it is felt that it would be a shame to sell her for a few dollars. The suggestion has been made that when her span of life is over she be sailed through the Panama Canal to some berth in an Eastern Canadian port and there, as the first ship to circumnavigate the continent, to rest as a memorial.

"Exercise Musk-Ox and the Canadian Arctic"

J. TUZO WILSON, O.B.E., Ph.D.

Professor of Geophysics, University of Toronto.

January 4th, 1947.

During the war small units of the Canadian Army were stationed at various times in northern countries, including Spitzbergen, Iceland, and the Aleutians. As a result special types of equipment were developed for use in very cold climates, and at the close of hostilities it was decided to test this equipment for peacetime purposes in Canada's far north. Accordingly "Exercise Musk-Ox" was organized. It was planned so as to be able to collect information about Canada's arctic and sub-arctic regions, the importance of which is indicated by the fact that 32 per cent of the Dominion's land area is north of the tree-line. To this end experts on mapping, meteorology, magnetism, navigation, and other sciences were taken on the exercise.

On February 15th, 1946, a force of forty-five men with eleven Canadian armoured snowmobiles and one "weasel" set out from Churchill.

In eighty-one days the force covered 3,100 miles, 2,400 miles of which were entirely without roads, and 1,700 miles of which had never been travelled before except by dog sled. It proceeded from Churchill to Baker Lake (where an advance party had prepared an ice strip for airplane landing) to Cambridge Bay on the Arctic Ocean, thence to Victoria Island, Coppermine, and Norman Wells, whence it followed an abandoned tractor trail to the Alcan highway and proceeded south to Grand Prairie where the trip was completed on May 6th, 1946. Roughly the course followed from Churchill was 1,000 miles north, 1,000 miles west and 1,000 miles south. The force was supplied by parachute from airplanes with bases at Churchill, Edmonton, and Norman Wells. A measure of the efficiency of this system of air supply is the fact that members of the force received letters from eastern Canada in two days and from England in six days from the time of mailing, as well as their food, fuel and other supplies. A remarkable feature was that most of the supplies were carried in large wheeled planes that dropped supplies where they could not land on the ice.

That snowmobiles can travel anywhere in the Canadian arctic regions (sometimes making 100 miles a day) that dog teams can, and in a fraction of the time, was clearly demonstrated.

Information was obtained as to the efficiency of cold weather equipment. It was found that snowmobiles, radio and planes after standing

a night in temperatures as low as 50 degrees below zero, could be operated readily. Observations were made regarding the relative merits of motor lubricants and the best food and clothing for the conditions encountered. The health of the members of the force was generally better at the conclusion than at the beginning. Information obtained will aid in prospecting for minerals in hitherto unexploited regions and has already stimulated action in this respect at Baker Lake. An air strip has since been built on a gravel beach there using Musk-Ox equipment.

The exercise proved of importance for meteorology. Observations made by meteorologists and transmitted by radio improved weather forecasts in southern Canada. The importance of establishing weather stations in northern Canada is indicated by the experience of Russia where the extensive system of meteorological stations in Siberia makes possible the operation of a shipping service along that arctic coast.

New techniques for throwing back the old frontier of the north have been demonstrated. Other nations have done much more with their north countries than has Canada. It may be hoped that "Exercise Musk-Ox" will contribute to our awakening realization of our opportunities and responsibilities in the north.

"Great Slave Lake"

A Problem in the Best Use of Resources.

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January 11th, 1947.

Development of the natural resources of timber, agricultural lands, minerals and fish of Canada's Northwest Territories presents a problem in co-ordination. In recent years Government experts have been mapping the forests and minerals and have studied problems of transportation, health and education.

As a part of this broad plan a survey of Great Slave Lake was inaugurated in May, 1944, its purpose being to find, by the application of scientific principles and techniques, how much fish could be taken out of the lake without imperilling the already uncertain living of the native population. A further purpose was to help set up a sound programme of utilization and management; to put into practice what conservationists have been advocating for many years.

Great Slave Lake is the fifth largest on the continent and one of the few large lakes unexploited commercially. Its area is 10,500 square miles and it has a greatest depth of 2,000 feet. Its fish population consists of trout up to forty or fifty pounds, excellent whitefish, large inconnu and twenty-two other species.

Starting the survey with a small crew and rented boats, most of the lake was explored in 1944. The survey was continued in 1945 with specially built boats and with larger crews. It was finished in the summer of 1946. To safeguard the future of the resources a careful check will have to be kept on the progress of fishing and its effect on the fish population.

From the evidence gathered it is estimated that at least four million pounds a year can be taken out of the lake; three million for commercial purposes, and one million required to feed the local population and their dog teams. The estimate is arrived at in two ways: by testing by many dredgings the fish food supply, showing what quantity of animals in pounds per acre inhabit the bottom, and by sampling the microscopic life all through the water by means of silk nets of 30,000 meshes to the square inch. These findings are compared with other lakes whose food supply and fish production are know from long experience.

In 1945 commercial fishing began, one and one-half million pounds of trout and whitefish being taken. In 1946 the catch was more than two million pounds. Boats bring the fish to camp within two to four hours after lifting nets. They are filleted, wrapped, prepared in quick freeze equipment and stored in great refrigerator barges ready for a 500 mile trip to railhead, and thence 2,000 to Chicago or New York markets where they command a premium price.

"Modern Trends in Photographic Colour Printing"

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January 18th, 1947.

Although colour has been possible in photography for half a century it has been suitable for casual use by the general public only in the last ten years during which many people used 35mm. colour transparencies with considerable satisfaction. In the last five years these transparencies have been printed on opaque materials to make colour prints.

Certain fundamentals of colour may be considered. To the physicist it means certain wave lengths of light; to the chemist it means materials which have light absorption properties; and to the psychologist it means certain responses in the brain.

In photography we are concerned with all three aspects of colour. Though there are over 2,000 different colours recognizable by the observer with normal vision, these are represented photographically by three coloured layers. The reason why three layers suffice is psychological. All eyes have rods which perceive merely shades of grey. All normal human eyes have also cones which perceive colour and which are of three types—those most sensitive to violet, those most sensitive to green, and those most sensitive to red.

Since this is the mechanism of human vision, three projectors (each covered by a filter—red, green or blue) can be used to simulate any colour. Red, green, and blue light can be adjusted in intensity to give, when combined, any recognizable colour, and some of the early schemes for colour photography were based on this principle, leading eventually to the introduction of monopack material. This consists of a film base which is coated by three sensitive layers recording respectively the blue, green, and red of the original subject. Such films must be developed as negatives and then their colour developed. In one process a different developer must be used for each of the three layers. The Ansco process requires only one developing agent.

The same basic theory of colour film applies to colour prints. The principal modern subtractive colour printing processes are carbro, dye transfer, Gasparcolor, and Printon. Carbro is the earliest of the colour processes still in use and the most complex and difficult. It requires three separate negatives for blue, green, and red records, and also manual dexterity and carefully controlled temperature and humidity conditions. The dye transfer process also requires the use of separation negatives which are printed on a special film.

In Gasparcolor and the Ansco Colour Printon processes the dyes are present in three emulsion layers coated on the material by the manufacturer, the layers being blue, green, and red sensitive. Separation negatives are not used in either of these two processes, which are comparatively direct.

The most recent approach to the problem of colour photography is to start with a colour negative which can be made several times as fast as the present colour positive film and can be used in any camera in which black and white can be used. The colour negative is then printed on monopack opaque material as a positive colour print.

"The Atmosphere in Motion"

C.-G. ROSSBY, Sc.D.

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January 25th, 1947.

The establishment of meteorological stations is a part of the international moral obligation of modern nations. It is a recognition on the part of one country of the principle of fair exchange for information received from other countries. The importance of this exchange has been vastly increased by the growth of aviation, and the last war gave great impetus both to its scope and to its techniques.

The first step in this international co-operation was taken during the Crimean war when the French Academy of Science had conducted under Le Verrier an investigation of a storm across Europe which had destroyed a number of ships at Sebastopol. It was thus found that by collecting station reports, storms could be tracked across a continent.

The second World War brought about important developments in techniques, notably radar photography. It was made possible to extend observations of the upper atmosphere by means of radio sounds up to 75,000 feet. Thus the upper winds and temperatures can be observed when balloons are obscured by weather. This is of special importance in long-term forecasting.

Modern aviation more than any other cause makes imperative the international exchange of weather information. For instance, it is necessary that a pilot taking off from Copenhagen for New York should know at starting not only the atmospheric conditions at New York, but for a radius of 500 miles around in order to be prepared to make alternative landings. For this reason a great deal more international co-operation and co-ordination are desirable. The importance of the International Meteorological Organization of which meetings are held to arrange the procedure for this exchange is thus obvious. For the first time in history its meeting will be held on this side of the Atlantic in 1947.

The atmosphere over the whole earth is in motion. Over great areas the trade winds blow constantly from one direction. In the temperate zone there it a great drift of air from west to east that extends from the surface up to the stratosphere. A world-wide circulation also moves warm air at high levels from the Equator to the Poles. There are a definite

pulse and intensity in the circulation, and just as one finds it most convenient to measure the pulse of the blood by noting it in the wrist, so the atmospheric circulation can most easily be determined by measuring it in the belt between latitudes 55 and 35 degrees north.

In the winter the circulation is usually stronger than in summer and will continue above or below normal for a matter of three or four weeks. This indicates the existence of trends in the weather and the possibility of extended period forecast. In summer the circulation is weaker and persists usually for only two or three days with a corresponding shorter forecast-period.

"Engineering for To-Morrow"

A Round-up of New Developments and Discussion of Their Future Significance.

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February 1st, 1947.

While not many startling new principles in science and engineering were developed in recent years, during 1946 there was a consolidation of wartime developments in these fields that, it may be expected, lays the foundation for outstanding progress.

Engineers have developed new skills and the necessity for using substitutes has resulted, in many instances, in the discovery that the substitute is better than the original material.

Only two underlying principles have come out of the last six years in the opinion of representative engineers according to a recent survey. One has to do with atomic fission—the atomic bomb and the work pointing towards peace-time atomic power. The other is the manner of generation of ultra high frequency or micro-waves—the force behind radar, television and high frequency heating.

The potentialities of atomic energy are as yet little known, but it is probable that steam-turbine generators now being purchased will be retired by obsolescence and not by nuclear power generating equipment.

In the micro-wave field the engineer has been given a whole family of devices. Electronic tubes that can emit short bursts of power thousands

of times each second have been devised for radar, and engineers see no reason why a fifty million watt micro-wave generator cannot be produced. A use for such quantities of ultra high frequency power undoubtedly will be found.

Apart from the emergence of these two basic principles, the war brought about new skills and the use of new materials. Engineers now have the ability to study events that live and die in one-thousandth of a millionth of a second. They can make snapshot pictures of the inside of fast moving machines. The explored zones of the electro-magnetic spectrum have been increased one hundred times. Science has many devices, non-existent a decade ago, born of radar, that will be useful for increasing safety in air and sea travel, for better communications and for the transmission of television pictures in full colour.

The greatest revolution in aircraft propulsion will probably be the gas turbine. The gyroscope was brought to its full importance by the war; controlling the firing of guns of tanks while in motion, and holding steady the radar antennæ of ships in spite of pitch and roll. In peacetime, gyroscopes will enable trains to traverse sharp curves faster with comfort and safety. Metals have been developed which can withstand eight times more stress at high temperatures than was possible before the war. Silicons are taking an important place in industry especially in insulators and high temperature lubricants. Electronic calculators now reduce the solving of problems of mechanics, hydraulics, and heat flow from man-years of work to man-hours.

"Wind, Sea, and Swell"

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February 8th, 1947.

In the days of the sailing ships, many an old sailor had an uncanny knowledge of the sea. From the experience of a lifetime he would know that the waves raised directly by the wind would depend upon the violence of the wind, the stretch of water over which it had blown, or the length of time it had been blowing. He would know that the large waves generated directly by the wind would continue to travel through regions of calm as swell which would become longer and more regular with increasing distance from the storm area. Even if the swell could not be observed with the eye, he would notice its presence from the very feel of his ship, and take warning of an approaching storm.

Much of this knowledge was forgotten with the introduction of steam. But during the recent war it became vitally important to develop methods for forecasting sea and swell in connection with operations of aircraft carriers, rescue work at sea and, most importantly, in connection with amphibious operations.

For a century observations of sea and swell have been carried out intermittently, but only in recent years, under stress of war, has it been possible to fit these empirical data into a consistent framework showing a relationship between wind, waves, and swell. It is now realized that when the wind blows over the ocean it does not generate a single train of waves, but it generates a spectrum of waves of different periods and heights, many travelling in slightly different directions resulting in a sea surface of very complicated appearance.

If the wind systems over the ocean are known, also can be known the accompanying waves which, as they advance from the storm area, travel over long distances as swell. The laws of the advance of swell and its decrease in height have been established, and with the aid of sensitive instruments and with the oceanic weather maps at one's disposal, the arrival of a swell at a distant coast can be forecast.

The surf and height of the breakers caused by swell vary greatly along coasts, but these variations can be predicted if the configuration of the coast line and the topography of the bottom are known. Conversely, from wave patterns observed photographically or visually from an airplane an experienced interpreter can immediately draw conclusions as to some of the bottom features and depths with an accuracy of a foot.

This method is one of many which were developed during the war for determining depth off enemy-held beaches.

The techniques for predicting conditions of surf in planned amphibious operations by study of the wind long in advance found application throughout the war. One of the most brilliant of such predictions was made in connection with the landings on Sicily.

The use of the records of swell will probaby find an important application in amplifying the weather maps over ocean areas. The swell carries the imprint of the storm by which it was generated, and some of the components in the swell travel so fast that they reach a distant coast long before the storm arrives. The meteorological information from ocean areas is often so scanty that the weather forecaster has to make many guesses when preparing his weather map. The added information about the storm areas which is carried by the forerunners of swell may serve to reduce the number of guesses and place the construction of weather maps on a firmer basis.

"Parks, People and Predators"

VICTOR H. CAHALANE, B.S., M.F.

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February 15th, 1947.

The greatest aggregation of wildlife ever seen was found by the early settlers of temperate North America. Wasteful exploitation wiped out much of it and resulted in the passing of an act of Congress in 1872 by which over 3,000 square miles of the Yellowstone region were set apart as the first national park. It has been followed in the United States by twenty-six additional parks. Canada has set aside twenty-five areas totalling 11,800 square miles. Mexico has named forty-three national parks. The idea has spread beyond this continent and become an international instrument for saving important plant communities and conserving vanishing species of wildlife.

Nevertheless, the rate of extinction of wildlife in the world is accelerating. In the past 2,000 years, 106 species of mammals have become extinct; more than half in the last 100 years.

There are forces and interests working towards further extirpation today.

The object of national parks is to save a portion of the original animals by saving their habitat. They are the only places in the world where the disturbance of all of nature's inter-relationships is prevented by law. These areas are threatened by commercial interests including those of lumber, power, ranching, mining, oil, gas, and others.

The national parks of the United States give sanctuary to hundreds of thousands of wild animals. In Yellowstone National Park alone, there are 14,000 elk, 1,000 buffalo, 700 deer, 800 antelope, 600 moose, 650 bears, 280 mountain sheep, and many other smaller species. It is a fascinating experience to see these animals going about their daily lives without fear of the rifle and shot gun.

There is only one class of wildlife where this protection is viewed with misgivings or worse. These are the predators. Their extermination has been vigorously urged. When the cougars and wolves were eliminated from Yellowstone, the big game animals increased to such numbers that

thousands of them starved to death. They damaged their limited winter range to such an extent that it will take decades to recover.

This result of predator control, and other factors, caused the evolution of a more realistic wildlife policy. No native predator may be destroyed merely because it eats meat. Individuals may be removed, if, by scientific inquiry, it is determined that a prey species is in danger of extermination.

After twelve years of complete protection of the coyote in Yellowstone, it was found that these predators had had no appreciable effect on the numbers of prey animals. In spite of their great birth rate, the coyotes had not increased.

The wolf-sheep controversy at Mount McKinley is the Park Service's most important current problem. Legislation has been proposed to exterminate the wolf in Mount McKinley National Park because of the recent decline of Dall sheep numbers to 500. In the winter of 1945-46 it was found that wolves in the Park had already been reduced by natural causes from 50 to 10. No more than 15 have been in the Park since that time.

Sheep and wolves have existed on the same range for thousands of years. There is no proof that wolves suddenly caused the sharp decline of the sheep population. On the contrary, there is some evidence that a large age-class of old sheep, survivors of the severe winter of 1932, came to the end of their natural life span. However, to provide all possible help to the threatened species, wolves up to 15 in number are to be shot if seen. Five were destroyed last summer.

In 1945, the lamb crop was only 10 to 15 per cent. of the ewes. In 1946 it was much better—39 per cent. There is good reason to believe that the sheep will recover. As soon as an upward trend of the sheep population is clearly apparent, the need for control of wolf numbers will have passed. There is no point in artificially building up the numbers of sheep until thousands of them starve to death for lack of winter forage, as they did in the winters of 1929 and 1932.

"Nature's Gifts to China"

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February 22nd, 1947.

China's major geographic division is between north and south. The different gifts of nature which provide the basic requisites for livelihood have resulted in variations in the modes of life of the two populations, affecting even their temperaments.

North China with its 200 millions population has a dry brown landscape, with wheat as its chief crop, its cities have wide streets that give a sense of comparative spaciousness.

By contrast, the 275 millions of the south depend basically on rice. The land has abundant rainfall and many areas are richly forested. The cities are congested communities with narrow streets. The population is so dense that it overflows to find accommodation in boats on rivers and harbours.

China is abundantly supplied with coal, ranking fourth among the nations of the world, but it is poor in other minerals and it is not to be expected that it will ever become a great industrial nation. It is likely that its future is that of a predominantly agricultural country.

Two major factors condition its probable future: the great pressure of population, and the psychological conflict between the old and the new.

Its population of 475 millions is distributed according to the productivity of the land, of which there is not an arable spot which has not been hunted out and exploited by man in his quest for food. The over-all equation between population and soil is indicated by the fact that the average of food-producing land is less than a half acre per capita.

Why China is so full of people goes back to Confucius and the emphasis in his teachings on ancestor reverence and the continuity of the family. Billions of people have lived in China. The conclusion seems inescapable that with a smaller population it would be a happier country.

In China's long history there have been half a dozen great dynasties, in between which have come periods of anarchy and chaos. We are now seeing the country in one of these times of transition, between the last

dynasty, which was overthrown by the revolution of 1911, and whatever the future may hold. There is contrast and confusion in the minds of the Chinese, who have just discovered the West. Their psychology combines a curious mixture of modern thought and inherited superstition.

In speculating on the probable outcome of these conditions it should not be forgotten that the Chinese have lived a long time close to earth and with one another. Here is one of the most mature cultures on earth; nowhere else does man live closer to earth or to his fellow man.

"Light on Growing Children"

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March 1st, 1947.

The effect of schoolroom illumination on the health of children has been demonstrated in recent years to be far more extensive than had been previously supposed. Poor distribution of lighting can cause postural stresses, nutritional difficulties, and susceptibility to infection as well as impairment of eyesight and retardation in education.

These conclusions emerge as part of the findings from a long-range programme for protecting and promoting the health of school and pre-school children inauguarated by the Texas State Department of Health in January, 1939.

Lighting was singled out for special study in view of its great importance in education; and its less generally recognized effect on a whole chain of bodily activities which is set into action by "seeing." It directly affects growth both as to rate and as to pattern. Continued stresses induced by poor distribution of light, by bad contrasts, and by glare use energy needed for growth, for body function, for protection against infection, and for defence.

The importance of this consideration was sensationally demonstrated by the effects of lighting improvements on the health of children in experimental schools over a six months period. The children covered by this phase of the study numbered forty thousand. After correcting illumination in the schools under the survey, it was found that there had been spontaneous recoveries in 65 per cent of visual difficulties; in 45 per cent of nutritional disturbances; in 40 per cent of infections.

The kind of steps that were taken to improve lighting in all the schools in the programme may be illustrated by a single example, a school at Mexia, Texas. One room in the school was left unchanged as a "control" room. Three other rooms were changed by redecoration, altered pattern of seating, and controls at the windows for light diffusion.

The child in the unchanged "control" room was struggling with every kind of lighting extreme. Intensities on working surfaces varied by a ratio of over 18 to 1; and a brightness ratio of over 217 to 1. In the improved rooms the intensities varied by a ratio of less than 8 to 1; and brightness by a ratio of less than 5 to 1.

It has also been found that, at the same time that the children's health difficulties went down, their performance records went up. In one of the demonstration schools, during a six months period of working in day-light-controlled classroom environment, the children grew a mean average of 10.2 months in educational age. In the "control" room the mean average growth was 6.8 months in educational age.

"Molecules for the Millions"

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March 8th, 1947.

Under the impetus of war, plastics were developed into one of the most versatile materials known to man. While they are by no means the answer to all production needs, they are finding in peacetime an expanding area of usefulness not served by the older and more familiar materials such as metals, wood, glass, or leather. Many of the plastics now entering production will improve almost every aspect of life in the near future.

"Plastics" is a generic term for a wide range of synthetic resins each of which is made to exact specifications for a definite purpose. Of especial interest and importance is the new group known as Silicones. These plastics have as their molecular backbone the chemical elements silicon and oxygen arranged in a structural pattern similar to that found in sand. In combination with other synthetic ingredients, silicones provide resistance to heat and cold, superior insulation, water repellent qualities, and chemical inertness.

The demand for small, powerful motors for the armed forces led to the development of a silicone varnish with high insulating properties. By

combining silicone and carbon a synthetic rubber was constructed which could withstand extremes of heat and cold. It was of great use in arctic regions for gaskets on ships' searchlights, where there was a range of more than 500 degrees between the interior and exterior temperatures.

Tests are being made of a silicone paint that will give a surface almost impervious to chemical or temperature changes. A silicone vapour will render water-repellent any fabric without affecting its colour or texture and at the same time leaving it porous for ventilation. This water-repellent will be generally available in a year or two.

Silicone lubricants have been developed capable of resisting the terrific pressures and temperatures in high-speed and high-altitude aircraft. It is probable that this silicone lubricant will make unnecessary the use of different motor oils for winter and summer.

Another group of plastics with a promising future is the low-pressure laminates. These consist of alternating sheets of material, such as canvas or glass fabrics, impregnated with resins. They are readily molded, which permits the production of a variety of articles both light and strong. A 12-foot plastic dinghy has all the conventional sailing characteristics and is light, tough and unsinkable. A comparison shows this boat, new, to weigh 200 pounds and a similar wooden craft, 350 pounds. A plastic collapsible canoe in production, weighing only 65 pounds, can be fitted into the trunk of an automobile.

Electronic heating with frequencies up to 40 million cycles per second makes possible cheaper, more complex, and better plastic products. The thermo-setting plastics are heated through evenly and quickly by the molecular agitation caused by the electromagnetic waves alternating through the material.

"The Pitch, Loudness and Quality of Musical Tones"

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March 15th, 1947.

Engineers desire to know what measurable physical characteristics of musical tones will affect their psychological aspects. As a result of work in this direction, the tone-synthesizer was constructed just before the War.

It produces one hundred pure tones and various combinations of these, and has possibilities of producing almost an infinite variety of tone colour or timbre.

There are five important characteristics which can be measured: namely, intensity-levels, frequency, overtone-structure, duration, and growth and decay-rates.

The intensity-level is measured in decibels which can be read directly from a sound-level meter. Frequency of vibration is the rate at which the air is pushed back and forth when a note is sounded. When the tone has only one frequency it is called a pure tone and by mixing several of these together a complex tone is achieved. By adjustment of controls on the synthesizer, components of various frequencies and intensities may be combined resulting in overtone-structures which can be represented in tables and graphs.

Finally, engineers can measure the duration of the tone and how fast it grows towards its maximum intensity and how fast it dies away. They desire a more definite concept of duration than that given by the musical notations of the note to be played such as a whole, a half, a quarter or an eighth; and they measure how the intensity of a tone throughout its duration varies from the attack to the release. Thus a piano builds up to its maximum in about 1/100 second while it takes the organ ten times this long.

The psychological factors involved in loudness, pitch, and quality present difficulties in quantitative measurement.

The loudness of a musical tone as experienced by a typical observer depends upon the physical quantities of intensity, frequency, overtone-structure, and duration. Changes of intensity produce the major effect upon the loudness.

The pitch of a musical tone is that characteristic of the auditory sensation which enables the listener to locate the position of the tone on a musical scale. Because of its subjective character, the measurement of pitch can be made only by judgment tests. As in the case of loudness, pitch can be made definite only by choosing a reference standard—a tone having a constant loudness of 1,000 and capable of being varied in frequency throughout the audible range. The pitch of any other tone can be determined by comparing it with this reference.

The quality of tones depends principally upon the overtone-structure and the rates of growth and decay, but large changes in the intensity and the frequency also produce changes in quality.

With the tone-synthesizer it is possible to produce almost an infinite variety of musical tones and studies have been started to find new combinations with interesting possibilities. They may have considerable influence upon our future music.

"The Atom Bomb Tests at Bikini"

ERNEST W. STEDMAN, C.B., O.B.E.

Air Vice-Marshal (Ret.). Formerly member of Air Council for Research and Development, R.C.A.F.

March 22nd, 1947.

In view of the possible effects for good or ill of nuclear energy on the future of civilization, the atom bomb tests at Bikini on July 1st and July 25th, 1946, were appropriately designated "Operation Crossroads." The joint task force for carrying this out was under the command of Vice-Admiral W. H. P. Blandy, U.S.N. More than 40,000 naval, army, and civilian personnel took part in the operation. Eleven countries sent observers in addition to the U.S.A. The Canadian representation was seven officers, the lecturer being one of the number.

The first bomb, an air burst, was observed from a distance of twenty miles, which was too far for best results. For the second test, an under water explosion, observations were made at ten miles and one would not wish to be closer.

The visual effects were impressive and novel beyond description. However, the most accurate and scientifically valuable observations were made almost entirely by automatic means. Five hundred cameras were focussed on the explosions. Some were in pilotless "drone" aircraft almost directly above the detonations; others were placed on the target ships themselves, and still others were on towers especially erected on the nearby atoll. The cameras were all synchronized to take moving pictures and still photographs starting at the instant of the bomb's explosion. It was an example of excellent staff work in complex problems of co-ordination. Bags of radio-active gas were captured and automatically sealed by drone planes close to the centre of the explosion.

It was never intended to destroy the entire target of seventy-two warships. These were stationed at various distances from the explosions so that gradations in the amount of damage could be studied.

Conspicuous among the phenomena visually observable were the unusual, salmon-coloured glare of the flash; the formation of a smooth ice-crystal layer on top of the atomic cloud at a high altitude; the vapour ball caused by condensation which concealed the actual explosion and then quickly evaporated; the first air-shock wave which rippled over the surface of the ocean, and the secondary wave due to the movement of the water.

In the second explosion, a column of water half a mile in diameter was thrown up, rising for thirty seconds and descending for an equal period of time. The secondary wave from this engulfed the target ships and the radio-active water did most of the damage. Six months after the tests it was found necessary to tow the battleship "New York" to Pearl Harbour as no crew could be permitted on board the craft owing to radio-activity.

From the point of view of aviation, one of the most impressive parts of the tests was the operation of the pilotless planes. These drones were heavy Fortresses guided by mother planes miles away with great precision, and seem to open incalculable possibilities for the future.

"The Quebec Forest — Its Romance and History"

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March 29th, 1947.

Of Canada's vast woodlands, none have been trodden upon for so long, so intimately, so constantly by man and so deeply influenced by him as the Quebec forest. This forest has affected the pattern of settlement, the habits and ways of life, the songs and legends, the literature and art of French Canadians.

The Quebec forest divides itself into two fundamental types or formations, one of which spreads broadly north of the St. Lawrence River and the piedmont of the Laurentian Mountains. Here conifers predominate. The Great Lakes—St. Lawrence region of the forest, on the other hand, with its broad-leaved species, extends to the southern boundaries of the Province.

Of Quebec's 284,000 square miles south of latitude 52 degrees, 220,000 square miles are forest. They are being opened up at such a rate that in

less than a quarter of a century all the merchantable forest areas will be available to the pulp and paper industry whose greatest reservoir is the coniferous region. The development of the forest region must lead inevitably to the ultimate benefit of Canada and Quebec by opening up these territories at present inaccessible.

For nearly 500 years the Quebec forest has maintained strictly its original composition and distribution. We know its past history in the light of written documents. Cartiers' first *relation* in 1534 describes the shores of Gaspé: "These shores are mountainous and full of tall trees of many sorts such as cedar and hemlock." Again in 1535-36 he mentions "oaks, elms, ashes, butternuts, pines, firs, cedars, and hawthornes" on the present sites of Montreal and Quebec. In 1541-42 he writes ". . . moreover there are great stores of oaks, the most excellent that ever I saw in my life, which were so laden with mast (acorns) that they cracked again. Besides this there are fairer arables (maples), cedars, beeches and other trees than grow in France."

Champlain's *narrative* describes the forest of the Saguenay region. The Jesuit *relations* refer to "fearful mountains and forests so dense that the sun hardly ever succeeds in warming up the ground."

Colonization meant that the forest should recede before the assault of agriculture. From 1608 to date it has yielded more than 20 million acres to the pressure of French Canada's ever-increasing population. When farm areas are left undisturbed by human activity they soon revert to their primeval state.

The pioneer's fear of the forest with its manifold hazards is evidenced in the pattern of early settlement: the narrow width of land-holdings of 300 feet; the radial system of subdivisions with triangular holdings abutting on a common centre, where all houses were grouped in a defence village for security.

Among the educated there has always remained a constant nostalgia for the forest. Consider a comparison of this emotion in a 100-year-old writing on "Sugar Making" by Gerin Lajoie and the development of a similar theme in the contemporary work of Gabrielle Roy's "Sugar Maples." In art,the sculptors, Alfred Laliberte, Phillippe and Henri Hebert have expressed with feeling the interior flame of the pioneers, while the pioneers themselves carved out of wood their deep inner soul or their wishful longings.

Alone among the painters Clarence Gagnon has caught the subtle trepidations of light and shadow against the forested hills of the Laurentians. While a whole Pleiad of native artists is forever surging in Ontario,

Quebec has always looked to France for its art teachers and forgotten that art is self expression and translation of one's environment in absolute and sincere expression. There is yet to come an artist of the rugged pines, of the silvery birches, of the sombre green spruces, of the desolation of the burnt forest, of the sub-Arctic wastes of old Quebec!

Tales and legends of the forest have enjoyed a long popularity with French Canadians. These tales and legends have found in Abbé Casgrain, Pamphile Lemay, Louis Fréchette, and J. C. Tache, their better known bards. Marius Barbeau has kept up the tradition by innumerable recordings of local variants of the songs of voyageurs and foresters.

A highly sensitive poetic insight has led Abbé Felix Antoine Savard closer and closer to the hearts of the present day lumberjack, log-driver, and settler.

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Hinde & Dauch Paper Co. of Canada Ltd.
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Hogg, Prof. Frank S.
Hogg, Stanton
Hogg, Dr T. H.
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Holden, Dr. Otto
Holman, Dr. William L.
Holmes, George L.
Holness, A. B.
Hooker, Dr. H. L.
Hooper, P. McF.
Hooper, V. A.
Hope, H. B.
Hopkins, Oliver B.
Hopkins, P. E.
Horning, J. H.
Horsey, J. William
Horsfall, Herbert H.
Howell, P. L.
Huffman, Geo.
Hughes, Hon. F. J.
Hughes, V. G.
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Hunter, Carl H.
Hurst, Fred C.
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Hyland, James

I.

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James, O. S.
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James, Dr. W. F.
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Jeffrey, Frank R.
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Johnston, Albert C.
Johnston, E. H.
Johnston, Iredell K.
Johnston, John
Johnston, J. G.
Johnston, Dr. R. A. A.
Johnston, R. W. S.
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Johnston, Mrs. W. D.
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Joy, E. Grahame
Jull, Mrs. J. W.

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Kelly, Wm. J.
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Kennedy, J. B.
Kennedy, John R.
Kent, H. F. E.
Kerr, L. W.
Kert, Lawrence
Kidd, John J.
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Kilpatrick, J. A.
King, Frederick C.
Kinnear, C. R.
Kinnear, Thos. H.
Kinsman, J. V.
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Kishbaugh, W.
Klawe, J. J.
Knight, H. Watson
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Kumaran, Dr. J. D. Sampath
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Lawson, Hugh H.
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Livingstone, H. E.

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Peterkin, J. E.
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Phillips, George E.
Phillips, Lt.-Col. W. E.
Pickard, Wm.
Pidduck, C. D.
Pidgeon, Prof. L. M.
Piersol. Prof. Wm. Hunter
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Pitt, Arnold
Pitts, W. J.
Playfair, Stuart B.
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Pollock, H. R.
Porrett, C. M.
Poucher, F. B.
Pounder, Prof. I. R.
Pounsett, F. H. R.
Powell, A.
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Price, John D.
Price, Leslie
Price, Vincent W.
Procter, Dr. William
Proctor, J. E.
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Publow, C. F.
Pullan, Harry
Pullen, Frank

R.

Radforth, Dr. N. W.
Rae, Robert
Rahlves, H. J.
Ransom, H. E.
Ransom, Mrs. H. E.
Rashall, L. D.
Raw, J. Frank
Rea, Thomas H.
Redelmeier, Wm.
Redpath, Wm.
Reid, F. D.
Reid, F. Gordon
Reid, James
Reid, R. P.
Rennie, Thos.
Rhind, John
Richards, V. L.
Richardson, F. L.
Richel, Bernard
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Ricker, E. A.
Riley, Harold
Rinaldo, W.
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Robertson, C. S.
Robertson, Percy
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Robinson, Dr. W. L.
Robinson, W. W.
Roden Brothers Ltd.
Roden, D.
Roebuck. The Hon. A. W.
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Russell, R. J. R.
Russell, Thos. B.
Rutledge, J. R.
Ryerson, Dr. E. S.

S.

Sagar, Prof. W. L.
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Salada Tea Co. of Canada Ltd.

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Sanderson, C. R.
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Seagram, Norman
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Seawright, J. B.
Sedgewick, R. M.
Sefton, F. H. C.
Seguin, A. H.
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Shannon, Frank
Shannon, H. B.
Sharp, Dr. Fletcher B.
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Smith, V. H.
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Steinberg, Leonard M.
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Stevenson, Collier
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T.

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